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## Monograph

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# The cavernicolous Oniscidea (Crustacea: Isopoda) of Portugal

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**Abstract.** The study of subterranean Oniscidea in Portugal has been neglected for nearly 70 years, but recent investigations have revealed high diversity. All the terrestrial isopods known from caves of mainland Portugal, including data from the literature and new material, are listed, revealing new biodiversity patterns. Twenty-seven species, belonging to 15 genera and six families, are known, of which 16 species are considered to be exclusively from subterranean ecosystems, i.e., troglobionts. Trichoniscidae is the most diverse family. Seven species in the family Trichoniscidae and one species in the family Styloniscidae are described as new (all with Reboleira & Taiti as authors): *Trichoniscoides bellesi* sp. nov. from the Montejunto Massif; *T. sicoensis* sp. nov. from the Sicó Massif; *Metatriconiscoides salirensis* sp. nov. from the typhonic valley of Caldas da Rainha; *Troglonethes olissipoensis* sp. nov. from the Lisbon Peninsula; *T. arrabidaensis* sp. nov. from the Arrábida Massif; *Miktoniscus longispina* sp. nov. from the Sicó Massif and Cesaredas Plateau; *Moserius inexpectatus* sp. nov. from the Estremenho Massif; and *Cordioniscus lusitanicus* sp. nov. from Alentejo and Algarve, the southernmost provinces of Portugal. The subgenus *Trogleluma* Vandel, 1946 (Armadillidiidae) is raised to genus level. In this geographic region terrestrial isopods are the richest group of cave-adapted animals.

**Key words.** Isopoda, new species, troglobiont, subterranean ecosystems, Iberian Peninsula.

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## Introduction

Terrestrial isopods (suborder Oniscidea) play a very important role in the decomposition of organic matter in land ecosystems (Hornung 2011). In subterranean ecosystems they occupy a key-ecological position, recycling organic detritus and being frequent prey of cave predators (Řezáč *et al.* 2008). Terrestrial isopods are successful land colonizers, but a great majority of species have a high dependence on hygrophilous habitats (Hornung 2011). In fact, they are quite abundant in subterranean ecosystems. Several species of oniscideans have adapted to the aphotic environment, where they can be found in the terrestrial and in the aquatic compartment, including species with amphibian behaviour (Taiti & Xue 2012; Broly *et al.* 2013; Campos-Filho *et al.* 2014).

Oniscidea represent the most diverse group among the Portuguese cave-obligate fauna (Reboleira *et al.* 2011a, 2013b). Taxonomic studies on the Oniscidea from mainland Portugal are scarce and included mainly in two publications recording epigeal and subterranean species by Arcangeli (1935a) and Vandel (1946), based on material collected by A. Barros Machado (for a complete list of Portuguese terrestrial isopods see Schmalzfuss 2003).

Prior to this study, only seven species of Oniscidea had been recorded as cave-adapted from karst massifs in mainland Portugal (Reboleira *et al.* 2011a, 2013b). Five species in the family Trichoniscidae were known: one from the north of the country (*Trichoniscoides serrai* Cruz, 1993) and four from central Portugal, i.e., *Trichoniscoides broteroi* Vandel, 1946 from the Sicó karst massif, and *T. subterraneus* Vandel, 1946, *T. meridionalis* Vandel, 1946 and *T. ouremensis* Vandel, 1946 from the Estremenho karst massif. The family Porcellionidae was represented by the species *Porcellio cavernicolus* Vandel, 1946, known from Sicó, and the family Armadillidiidae by *Troglarmadillium (Trogleluma) machadoi* Vandel, 1946, found in caves of the Algarve in the south of the country (Vandel 1946; Cruz 1993).

Recent investigations in caves of karst areas from Portugal revealed the presence of several new species of terrestrial isopods. The oniscidean fauna from the subterranean environment of mainland Portugal is here discussed based on literature data and the new material examined.

## Material and methods

Field work was performed between 2007 and 2014 in many karst caves from mainland Portugal and terrestrial isopods have been collected in 29 of these caves (Table 1, Fig. 1). The original Portuguese names for caves are maintained throughout the text, i.e., “Gruta” for a horizontal cave, “Algar” for a vertical cave and “Lapa” for a small cave.

Each cave was monitored in two different zones: just beyond the twilight zone and in its deeper parts. Specimens were collected using baited pitfall traps and active search in each cave, and most were preserved in 70% ethanol, while some specimens were preserved in 100% ethanol for future molecular analyses. Temperature was measured with an Aspiration Psychrometer 761 (Lambrecht, Göttingen).

Identifications are based on morphological characters and the pertinent literature. The terminology used in species descriptions is mainly based on Vandel (1960a, 1962). Specimens were studied under Wild

**Table 1.** Studied caves in Portugal. Coordinates: UTM WGS; E = entrance altitude in metres; T = mean temperature at soil level in °C.

Cave	Karst area	Coordinates	E	T
Gruta de Santo Adrião	Vimioso	41°32'53.9" N, 6°26'40.1" W	580	12.0
Gruta d'el Rey	Cantanhede	40°17'38.8" N, 8°32'49.3" W	70	13.2
Gruta da Arrifana	Sicó	40°05'22.53" N, 8°30'55.76" W	300	16.7
Gruta do Algarinho	Sicó	39°53'04.5" N, 8°23'05.0" W	208	14.9
Gruta do Soprador do Carvalho	Sicó	39°59'10.1" N, 8°22'57.7" W	20	15.1
Gruta da Senhora da Estrela	Sicó	39°55'41.2" N, 8°32'59.5" W	380	13.8
Gruta da Cerâmica	Sicó	39°55'36.6" N, 8°31'03.6" W	355	15.0
Algar da Ervilha	Sicó	39°56'23.54" N, 8°32'24.39" W	335	15.1
Gruta de São Simão	Sicó	39°57'47.31" N, 8°28'13.62" W	335	14.6
Gruta Abrigo Tomar I	Estremenho	39°39'34.7" N, 8°25'03.6" W	92	14.6
Gruta do Papagaio	Estremenho	39°36'12.17" N, 8°41'11.26" W	419	15.6
Gruta do Burro	Estremenho	39°36'48.43" N, 8°41'21.10" W	390	15.4
Algar do Ladoeiro	Estremenho	39°31'33.01" N, 8°45'15.58" W	485	15.5
Gruta dos Moinhos Velhos	Estremenho	39°32'25.5" N, 8°42'15.5" W	307	18.0
Gruta do Almonda	Estremenho	39°30'17.10" N, 8°36'54.40" W	95	18.0
Algar do Zé de Braga	Estremenho	39°29'16.02" N, 8°42'56.21" W	255	17.0
Algar do Vale da Pena	Estremenho	39°26'48.0" N, 8°55'56.8" W	294	14.3
Gruta de Salir	Caldas da Rainha	39°29'11.64" N, 9°09'56.39" W	60	17.3
Gruta dos Bolhos	Cesaredas	39°18'52.25" N, 9°16'61.37" W	145	16.3
Algar do Javali	Montejunto	39°11'96.5" N, 9°01'71.8" W	380	14.4
Gruta da Assafora	Lisbon Peninsula	38°54'24.80" N, 9°25'17.31" W	89	16.7
Gruta da Alvide	Lisbon Peninsula	38°42'35.7" N, 9°25'32.8" W	42	18.3
Gruta do Frade	Arrábida	38°25'46.56" N, 9°08'10.22" W	0	21.5
Lapa da Furada	Arrábida	38°25'45.8" N, 9°10'28.3" W	159	18.1
Algar de Santo António	Alandroal	34°42'14.2" N, 7°23'59.3" W	370	17.6
Gruta de Ibne Ammar	Algarve	37°09'24.9" N, 8°29'59.4" W	10	18.9
Algarão do Remexido	Algarve	37°14'29.5" N, 8°16'35.6" W	131	18.1
Gruta do Vale Telheiro	Algarve	37°10'13.1" N, 8°02'05.3" W	239	17.0
Gruta da Senhora	Algarve	37°06'20.5" N, 7°46'35.2" W	85	17.8

M5 and M20 microscopes and figures drawn with the aid of a camera lucida. Parts of specimens were mounted in micropreparations with Hoyer's liquid (Anderson 1954).

The ecological classification of species was made according to their degree of dependence on the subterranean environment using the Schiner-Racovitza system and following the same criteria as in Reboleira *et al.* (2011a): troglone species are those whose occurrence in caves is accidental; trogloniles, species with affinities to the subterranean environment and frequently found in it, but lacking troglomorphic traits, i.e., classical adaptations to subterranean life-style; and troglonions, species that exhibit a combination of depigmentation and lack or reduction of eyes, and are found exclusively in subterranean ecosystems.

All material was collected by A.S.P.S. Reboleira and has been deposited in the following collections:

MZUF = Museo di Storia Naturale dell'Università, Sezione di Zoologia "La Specola", Florence, Italy

SR = Sofia Reboleira collection, Universidade de Aveiro, Portugal

ZMUC = Zoological Museum, Natural History Museum of Denmark, University of Copenhagen



**Fig. 1.** Location of the main karst areas of Portugal. 1. Vimioso. 2. Cantanhede-Outil. 3. Sicó. 4. Estremenho. 5. Cesaredas. 6. Montejunto. 7. Lisbon Peninsula. 8. Arrábida. 9. Estremoz-Cano. 10. Algarve.

## Results

Class Malacostraca Latreille, 1802  
Order Isopoda Latreille, 1817  
Suborder Oniscidea Latreille, 1802  
Family Trichoniscidae Sars, 1899  
  
Genus *Trichoniscoides* Sars, 1899

### *Trichoniscoides broteroi* Vandel, 1946

*Trichoniscoides broteroi* Vandel, 1946: 178, figs 22–26.

*Trichoniscoides broteroi* – Vandel 1948: 129, fig. 14; 1952a: 264, figs 2, 12. — Schmölder 1965: 43, figs 120–122; 1971: 5, 78, 140, map 4. — Schmalfuss 2003: 302. — Reboleira *et al.* 2011a: 7, table 1.

## Records

Gruta dos Alqueves, Coimbra, Sicó Massif (Vandel 1946).

## Remarks

No specimens of this species were collected during our research. The type locality is now closed by the municipality and the whole surrounding area is urbanized.

## Distribution

Presently known only from the type locality.

### *Trichoniscoides machadoi* Vandel, 1946 Fig. 2A–C

*Trichoniscoides machadoi* Vandel, 1946: 168, figs 8–12.

*Trichoniscoides machadoi* – Vandel 1947: 270; 1948: 129, fig. 14; 1952a: 262, figs 2, 9. — Schmölder 1965: 37, figs 79–82; 1971: 4, 75, 139, map 4. — Schmalfuss 2003: 303.

## Material examined

PORTUGAL: 3 ♂♂, 4 ♀♀, Gruta d’el Rey, Cantanhede-Outil Massif, 8 Oct. 2009 (MZUF); 2 ♂♂, same locality, 19 May 2009 (SR); 1 ♂, 1 ♀, Gruta da Senhora, Algarve Massif, 29 Dec. 2009 (MZUF); 1 ♂, 1 ♀, Gruta Abrigo Tomar I, Sicó Massif, 26 Sep. 2011 (ZMUC).

## Previous records

Serra do Gerês, Terras de Bouro, Braga; Portunhos; Pampilhosa, Mealhada; Algar da Serra, Alvaiázere; Algar da Rocha, Souto, Sicó; Serra de Minde, Porto de Mós; Algarve da Terra da Rolha, Montejunto; Buracos Mineiros, Montejunto; Algarve nº1 da Senhora das Neves, Montejunto; Serra do Montejunto; Cruz Quebrada, Oeiras; Gruta do Algar, Mexilhoeirinha, Lagos (Vandel 1946).

## Remarks

The diagnostic features of this species, i.e., the male pereopod 7 and male pleopods 1 and 2, are illustrated in Fig. 2 from specimens collected in Gruta d’el Rey.

## Distribution

Species endemic to Portugal where it is widely distributed, from Serra do Gerês in the north to the Algarve in the south.

### Ecological notes

This species is both cavernicolous and endogean.

### *Trichoniscoides ouremensis* Vandel, 1946

*Trichoniscoides pseudomixtus ouremensis* Vandel, 1946: 177, figs 20–21.

*Trichoniscoides ouremensis* – Vandel 1952a: 263, figs 2, 10. — Schmölder 1965: 38, figs 91–92; 1971: 5, 76, 139, map 4. — Schmalfuss 2003: 304. — Reboleira *et al.* 2011a: 7, table 1.

### Records

Lapa da Salgada, Fátima, Vila Nova de Ourém (Vandel 1946).

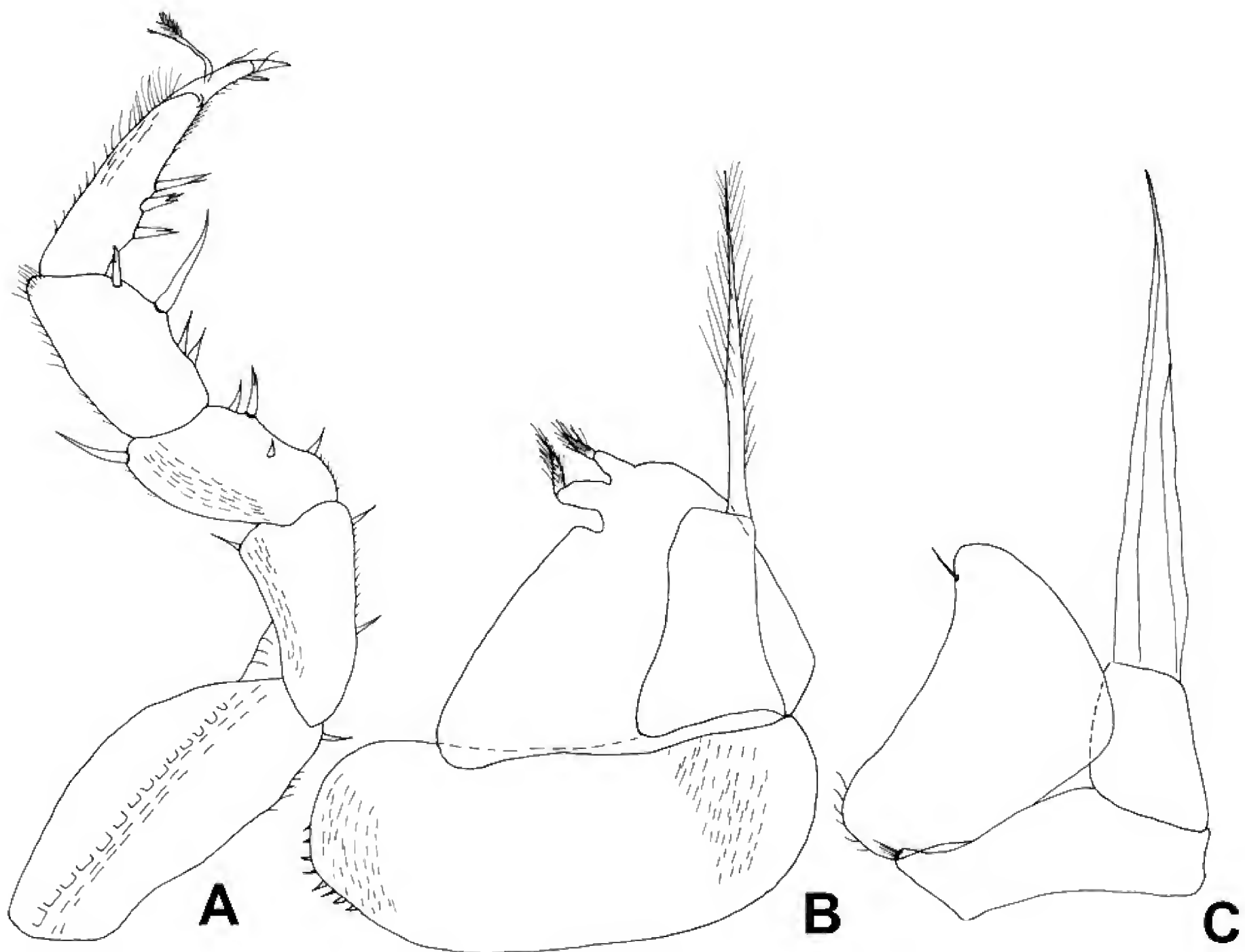
### Distribution

Species endemic to Portugal, presently only known from the type locality.

### *Trichoniscoides serrai* Cruz, 1993

*Trichoniscoides serrai* Cruz, 1993: 18, fig. 2a–h.

*Trichoniscoides serrai* – Schmalfuss 2003: 304.



**Fig. 2.** *Trichoniscoides machadoi* Vandel, 1946 from Gruta d'el Rey, Cantanhede-Outil, ♂. A. Pereopod 7. B. Pleopod 1. C. Pleopod 2.

**Records**

Gruta de Santo Adrião, Trás-os-Montes, Miranda do Douro (Cruz 1993).

**Distribution**

Species endemic to northern Portugal, known only from the type locality.

*Trichoniscoides subterraneus* Vandel, 1946

*Trichoniscoides machadoi subterraneus* Vandel, 1946: 173, figs 13–15.

*Trichoniscoides subterraneus* – Vandel 1952a: 264, figs 2, 11. — Schmölzer 1965: 42, figs 116–117; 1971: 5, 77, 140, map 4. — Schmalfuss 2003: 304. — Reboleira *et al.* 2011a: 7, table 1.

**Records**

Gruta Alta do Cabeço dos Mosqueiros, Aljubarrota, Alcobaça (Vandel 1946).

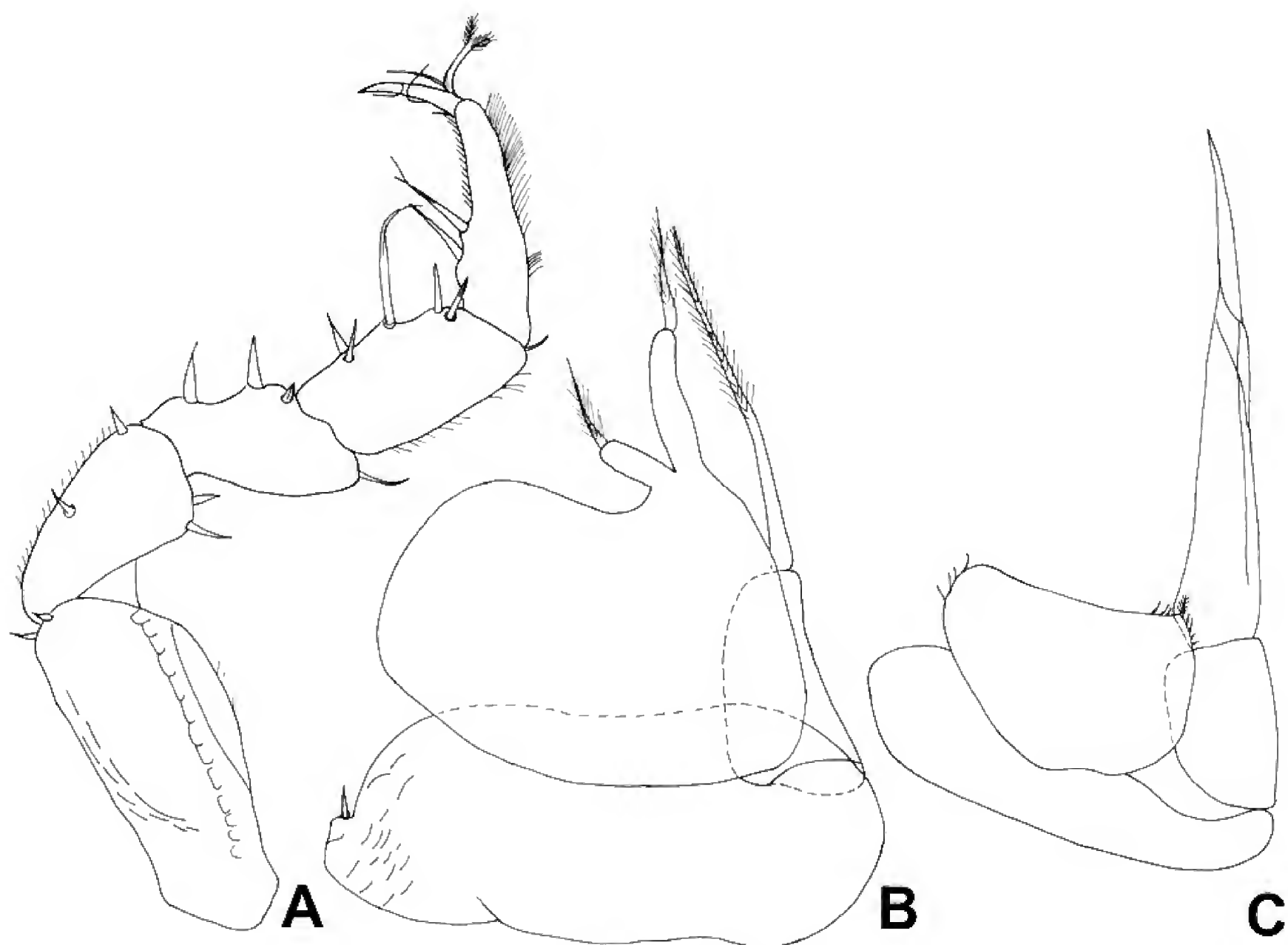
**Distribution**

Species endemic to central Portugal, known only from the type locality.

*Trichoniscoides meridionalis* Vandel, 1946

Fig. 3A–C

*Trichoniscoides pseudomixtus meridionalis* Vandel, 1946: 175, figs 16–19.



**Fig. 3.** *Trichoniscoides meridionalis* Vandel, 1946 from Gruta dos Moinhos, Velhos, Estremenho, ♂. A. Pereopod 7. B. Pleopod 1. C. Pleopod 2.



*Trichoniscoides meridionalis* – Vandel 1952a: 266, figs 2, 13. — Schmölzer 1965: 37, figs 83–84; 1971: 5, 75, 139, map 4. — Reboleira *et al.* 2011a: 7, table 1.

### Material examined

PORTUGAL: 4 ♂♂, 2 ♀♀, Gruta dos Moinhos Velhos, Estremenho Massif, 24 Mar. 2007 (MZUF); 3 ♂♂, 2 ♀♀, Algar do Vale da Pena, Estremenho Massif, 26 Jul. 2011 (SR); 1 ♂, 3 ♀♀, 1 juv., Algar do Burro, Estremenho Massif, 5 May 2014 (MZUF); 1 ♀, Algar do Zé de Braga, Estremenho Massif, 16 Feb. 2013 (SR); 7 ♂♂, 4 ♀♀, Algar do Ladoeiro, Estremenho Massif, 3 Feb. 2007 (MZUF); 3 ♂♂, 1 ♀, same locality, 6 Jan. 2007 (SR); 1 ♂, 1 ♀, 3 juvs, Gruta do Almonda, Estremenho Massif, 24 Aug. 2013 (MZUF); 1 ♀, same locality, 17 Feb. 2013 (SR); 3 ♂♂, 1 ♀, same locality, 25 Aug. 2013 (ZMUC); 1 ♂, Gruta do Papagaio, Estremenho Massif, 5 Apr. 2014 (MZUF).

### Previous records

Lapa da Chã de Cima, Porto de Mós, Leiria; Gruta das Alcobertas, Rio Maior, Santarém (Vandel 1946). Lapa dos Ladoeiros, Porto de Mós; Lapa da Ovelha, Serra de Minde, Santarém (Vandel 1952a).

### Distribution

This species is restricted to the Estremenho karst massif, in central-western Portugal.

### Remarks

This form was described by Vandel (1946) as a subspecies of *Trichoniscoides pseudomixtus* (Arcangeli, 1935), a species present in some caves of northeastern Spain. Vandel (1952a) elevated this form to species level. The male pereopod 7 and male pleopods 1 and 2 are illustrated in Fig. 3 from specimens collected in Gruta dos Moinhos Velhos.

### Ecological notes

This species can be found from the entrances to the deepest parts of the caves, normally associated with decomposing wood. It is distributed along the three main subunits of the Estremenho Massif, being the only troglotrophic oniscidean so far known from this large karst area. Contrary to other troglotrophic arthropods from the same massif, it does not present closely related species along the three subunits (Reboleira 2007; Reboleira *et al.* 2009). The biocoenosis of this karst area includes other troglotrophs, i.e., the spider *Nesticus lusitanicus* Fage, 1931, the campodeid *Podocampa cf. fragiloides* Silvestri, 1932, and the ground beetles *Trechus gamae* Reboleira & Serrano, 2009, *T. lunai* Reboleira & Serrano, 2009 and *T. machadoi* Jeannel, 1941 (Reboleira & Ortuño 2011; Reboleira *et al.* 2010b).

*Trichoniscoides bellesi* Reboleira & Taiti sp. nov.

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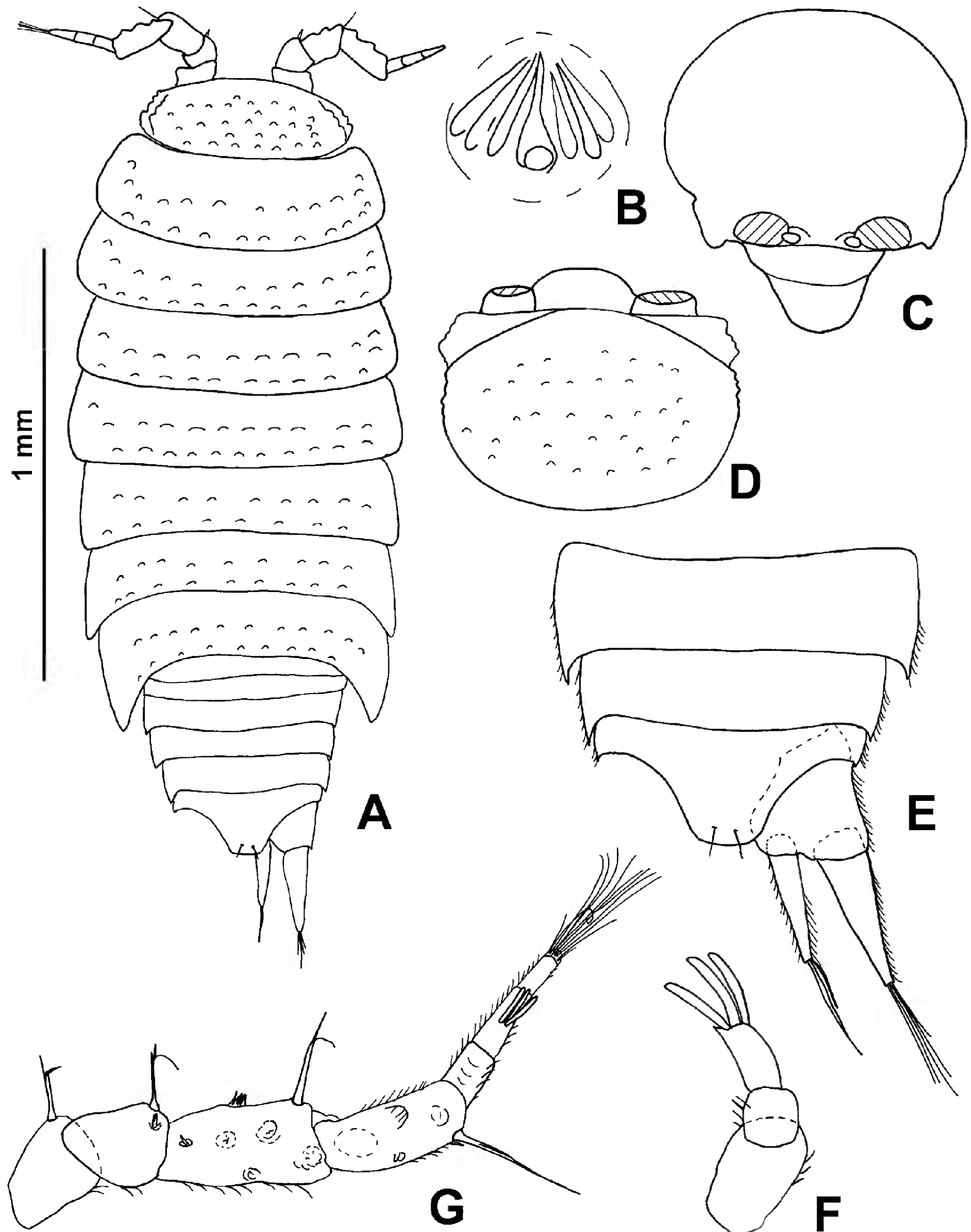
Figs 4A–G, 5A–E, 6A–D

### Diagnosis

A blind and colourless *Trichoniscoides* characterised by the male pleopod 1 exopod having a broadly rounded outer margin and two equal distal lobes, and the male pleopod 2 endopod having a distal article thickset for  $\frac{2}{3}$  of its length, ending with a narrow point.

### Etymology

The new species is named after Prof. Xavier Bellés for his invaluable contribution to the synthesis of knowledge on the subterranean fauna from the Iberian Peninsula.



**Fig. 4.** *Trichonisoides bellesi* Reboleira & Taiti sp. nov. from Algar do Javali, Montejunto. — Paratype, ♀. **A.** Adult specimen in dorsal view. **B.** Dorsal scale-seta. **C.** Cephalon in frontal view. **D.** Cephalon in dorsal view. — Paratype, ♂. **E.** Pleonites 4, 5, telson and right uropod. **F.** Antennula. **G.** Antenna.

**Material examined****Holotype**

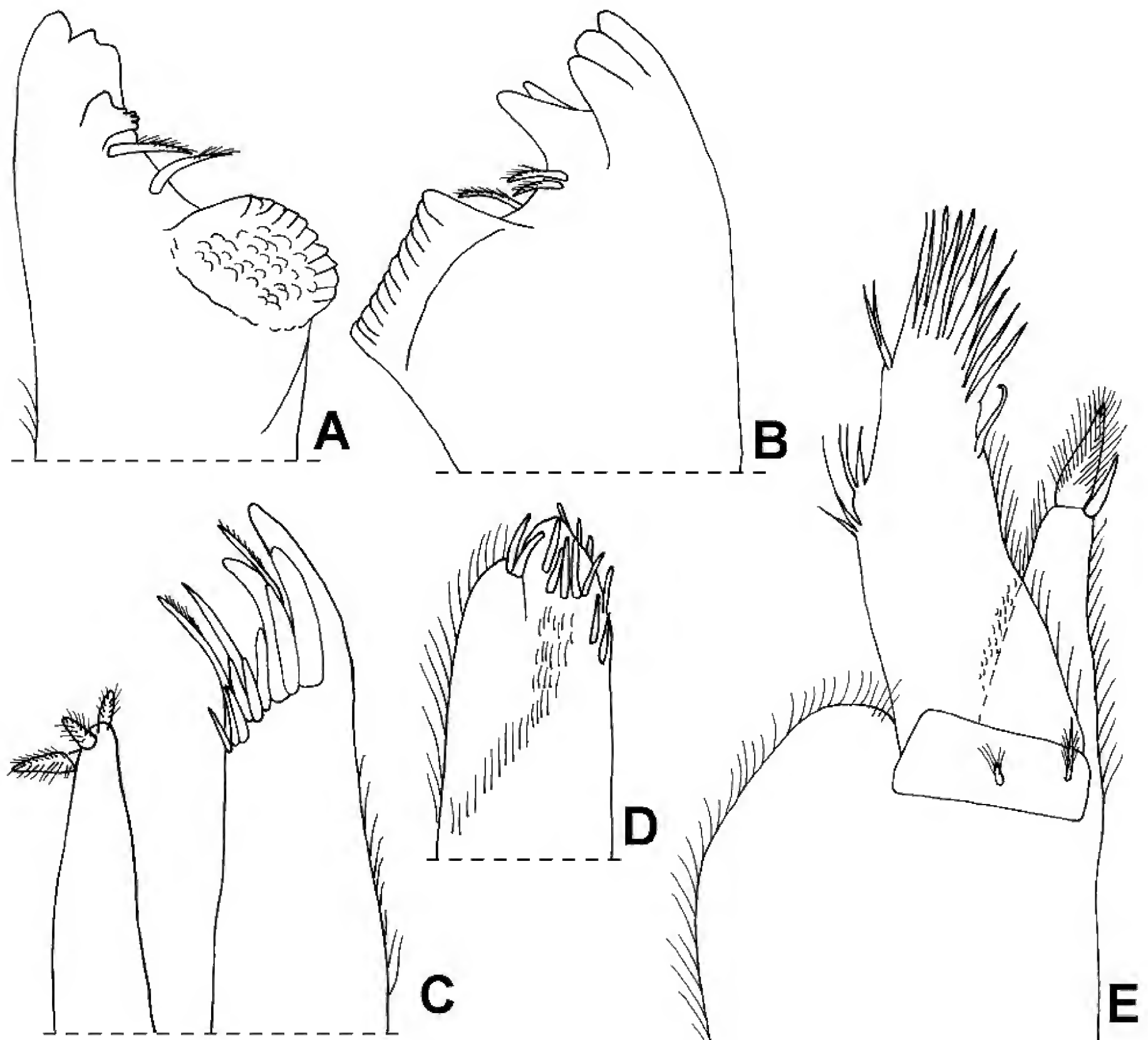
PORTUGAL: ♂, Algar do Javali, Montejunto Massif, 26 Dec. 2012 (MZUF).

**Paratypes**

PORTUGAL: 1 ♂, 1 ♀, same data as holotype (MZUF).

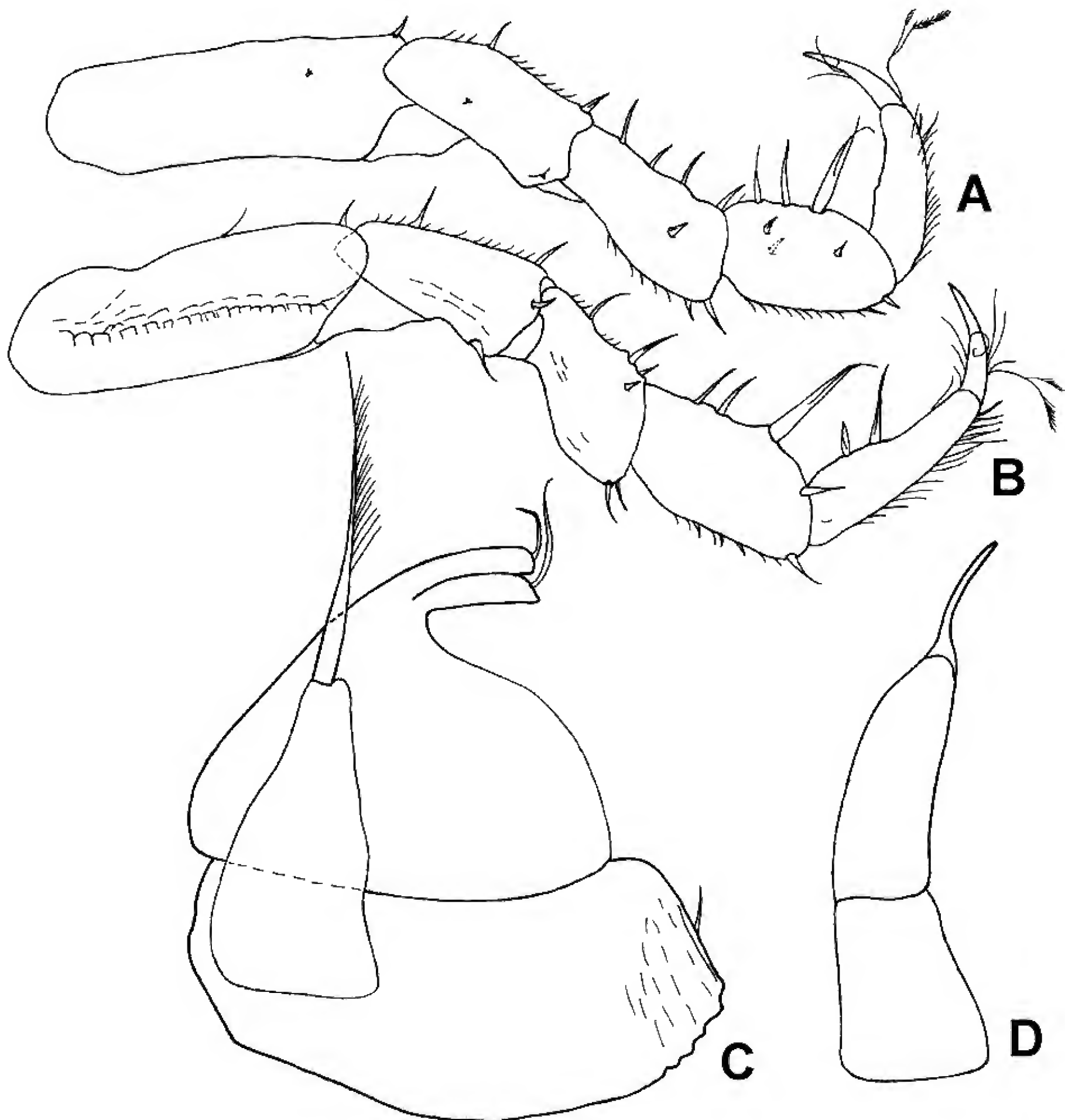
**Description**

Maximum size: ♂ 1.7 × 0.8 mm; ♀ 1.8 × 0.8 mm. Body colourless and slightly convex (Fig. 4A). Cephalon and pereon with granulated dorsal surface; granules on pereonites arranged in double rows; each granule bearing a triangular scale-seta (Fig. 4B) on top. Cephalon (Fig. 4C–D) with quadrangular frontal lateral lobes not protruding frontwards. Eyes absent. Pereonites 1–4 (Fig. 4A) with rounded posterior corners; pereonites 5–7 (Fig. 4A) with epimera pointing backwards. Pleon (Fig. 4A, E) narrower than pereon; pleonites 3–5 with small epimera and short posterior points. Telson (Fig. 4E) more than twice as wide as



**Fig. 5.** *Trichonisoides bellesi* Reboleira & Taiti sp. nov. from Algar do Javali, Montejunto, paratype, ♀. A. Right mandible. B. Left mandible. C. Maxillula. D. Maxilla. E. Maxilliped.

long, distal part trapezoidal with concave sides and slightly convex apex. Antennula (Fig. 4F) with three articles; third article with distinct spine and three long aesthetascs at apex. Antenna (Fig. 4G) with fifth article of peduncle shorter than flagellum; flagellum with three articles, with three long aesthetascs on second article. Mandibles (Fig. 5A–B) with two penicils on the right and three on the left; molar process without penicils. Maxillula (Fig. 5C) with inner branch bearing three penicils at apex, proximal one distinctly longer than other two; outer branch with 11 teeth and two thin stems, one among outer group and one among inner group of teeth. Maxilla (Fig. 5D) apically bilobed, with outer lobe smaller than inner one; inner lobe with several long, stout setae. Maxilliped (Fig. 5E) endite triangular, with stout penicil at apex; palp distally rounded, with long setae, basal article with two short, compound setae.



**Fig. 6.** *Trichonisoides bellesi* Reboleira & Taiti sp. nov. from Algar do Javali, Montejunto, paratype, ♂. **A.** Pereopod 1. **B.** Pereopod 7. **C.** Pleopod 1. **D.** Pleopod 2 endopod.

Uropod (Fig. 4E) with exopod distinctly longer than endopod; exopod with several long, pointed setae and endopod with a long and a short seta at apex.

MALE. Pereopod 1 (Fig. 6A) and pereopod 7 (Fig. 6B) with no particular modifications. Pleopod 1 (Fig. 6C) exopod almost as long as wide, with broadly rounded outer margin and two equal distal lobes each bearing a short seta at apex; endopod with triangular and flagelliform basal article and setose distal article. Pleopod 2 exopod missing in the specimen examined; endopod (Fig. 6D) biarticulated, distal article about twice as long as basal one, thickset for first  $\frac{2}{3}$  and ending with narrow point.

### Remarks

In the shape of the male pleopod 2 exopod, with a thickset distal article ending in a narrow point, the new species is similar to *Trichoniscoides lusitanus* Vandel, 1946, *T. broteroi* and *T. heroldi* Vandel, 1952. It differs from *T. lusitanus*, an epigeal species from north-western Spain and northern Portugal, in lacking eyes and pigment, in the male pleopod 1 endopod having a triangular basal article, and in the male pleopod 2 endopod having a stouter distal article ending in a shorter point; from *T. broteroi* in lacking the hook on the male pereopod 7 merus, and in the triangular shape of the basal article of the male pleopod 1 endopod; from *T. heroldi*, an epigeal species from eastern France, in the lack of eyes and the shape of the male pleopod 1.

### Ecological notes

*Trichoniscoides bellesi* sp. nov. is typically a troglotrophic species, lacking eyes and body pigment. It was discovered in the deepest and most thermally insulated parts of Algar do Javali, around 10 m deep. Javali is currently the richest cave of the Montejunto karst massif. Four other caves in the same massif were also sampled (Algar do Escorpião, Ralo das Fontainhas, Algar da Terra da Rolha and Buracos Mineiros) without recovering any specimens of *T. bellesi*. The subterranean community of Algar do Javali includes other troglotrophic species, such as the campodeid *Podocampa* cf. *fragiloides*, a species of the oniscidean genus *Paraschizidium* (see below), the ground beetle *Trechus tatai* Reboleira & Ortuño, 2010, a new pselaphid beetle, and the pseudoscorpions *Chthonius cardosoi* Zaragoza, 2012 and *Roncocreagris occidentalis* Zaragoza & Reboleira, 2013 (Reboleira *et al.* 2010a, 2013c).

### *Trichoniscoides sicoensis* Reboleira & Taiti sp. nov.

[urn:lsid:zoobank.org:act:FCBE373B-42CE-4305-A932-28D88355FFB8](http://urn:lsid:zoobank.org:act:FCBE373B-42CE-4305-A932-28D88355FFB8)

Figs 7A–G, 8A–E, 9A–E

### Diagnosis

A blind and colourless *Trichoniscoides* characterised by the male pereopod 7 merus having a lobe on the mid-sternal margin, the male pleopod 1 exopod having a broadly rounded outer margin and two unequal setae, the endopod having a fusiform distal article with a distinct circular suture in the middle, and the male pleopod 2 endopod having thickset distal article bearing two short triangular lobes and two setae at the apex.

### Etymology

The new species is named after the Sicó karst area, where the species occurs.

### Material examined

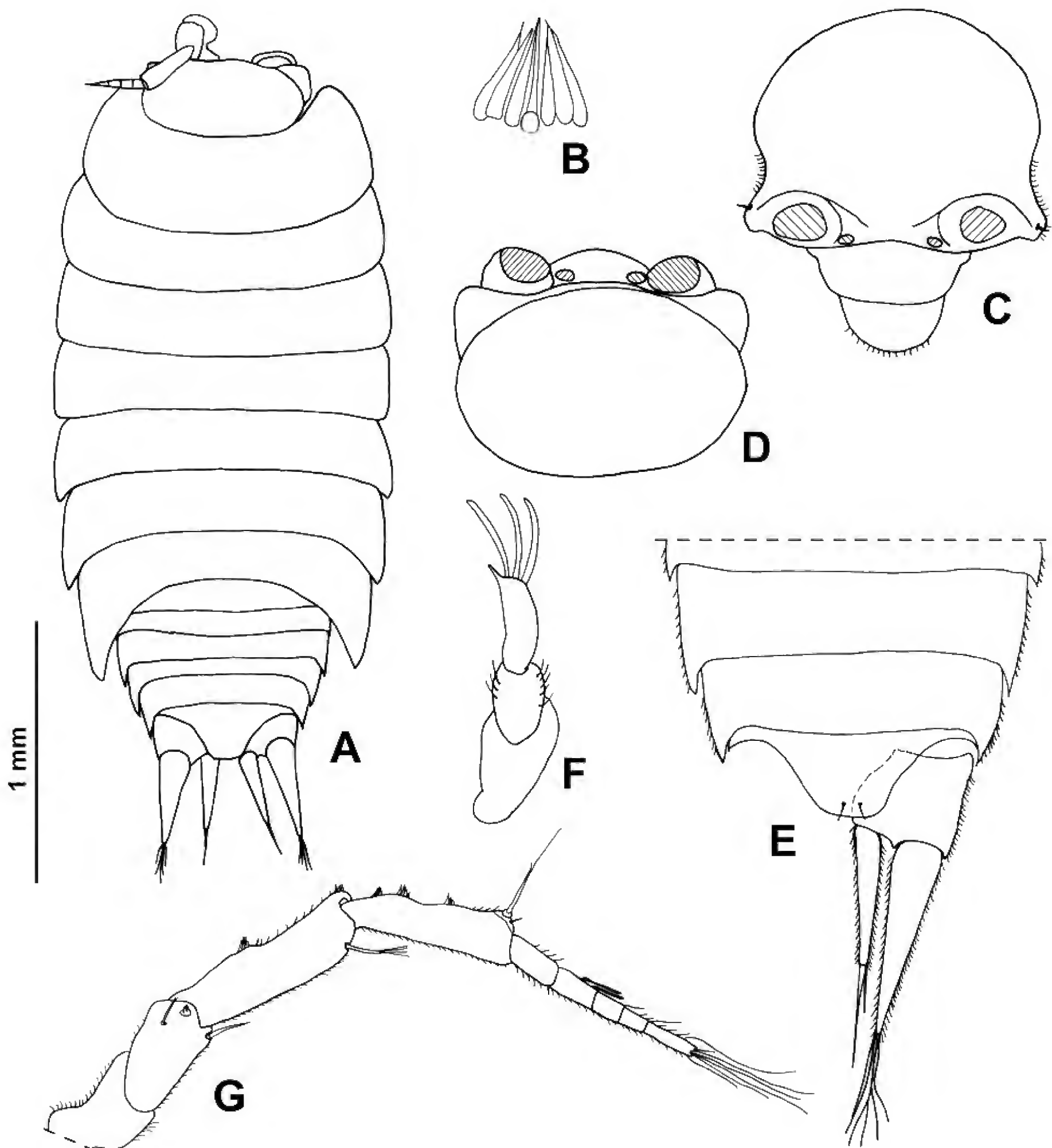
#### Holotype

PORTUGAL: ♂, Gruta da Cerâmica, Sicó Massif, 21 Mar. 2010 (MZUF).

#### Paratypes

PORTUGAL: 10 ♂♂, 12 ♀♀, Gruta da Cerâmica, Sicó, 21 Mar. 2010 (MZUF); 7 ♂♂, 11 ♀♀, same locality, 28 Nov. 2009 (SR); 4 ♂♂, 4 ♀♀, same locality, 10 Jun. 2011 (ZMUC); 4 ♂♂, 5 ♀♀, same

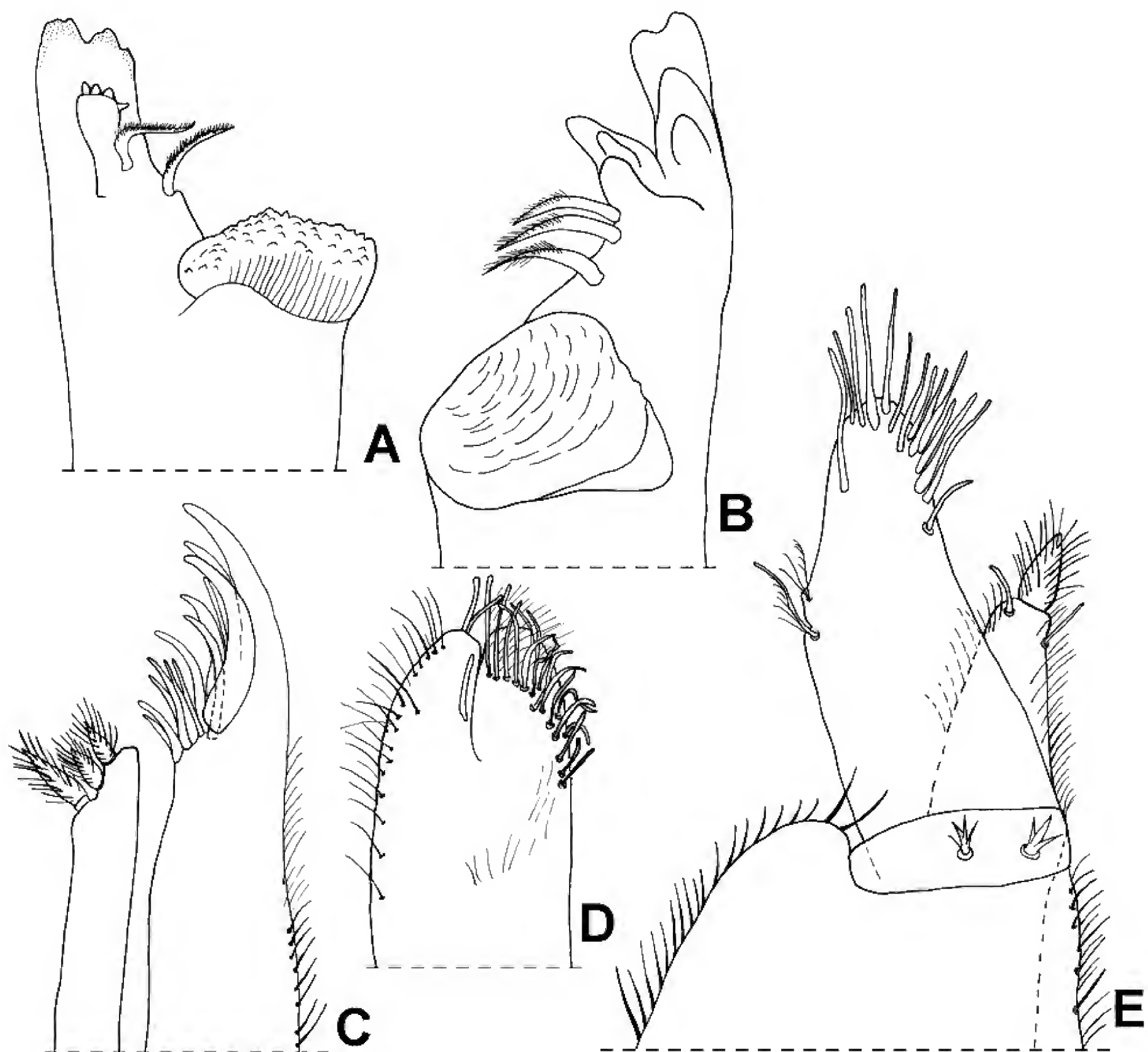
locality, 2 Mar. 2013 (MZUF); 12 ♂♂, 8 ♀♀, Gruta da Senhora da Estrela, Sicó, 20 Nov. 2009 (MZUF); 5 ♂♂, 12 ♀♀, same locality, 29 Aug. 2009 (SR); 3 ♂♂, same locality, 11 Jun. 2009 (ZMUC); 1 ♂, Gruta do Soprador do Carvalho, Sicó, 12 Jun. 2011 (SR); 2 ♂♂, 3 ♀♀, same locality, 8 Jun. 2013 (MZUF); 3 ♂♂, 2 ♀♀, Gruta do Algarinho, Sicó, 9 Jun. 2013 (SR); 3 ♂♂, 1 ♀, Gruta da Arrifana, Sicó, 12 Jan. 2013 (ZMUC); 1 ♂, 2 ♀♀, Gruta de São Simão, Sicó, 30 Nov. 2013 (MZUF).



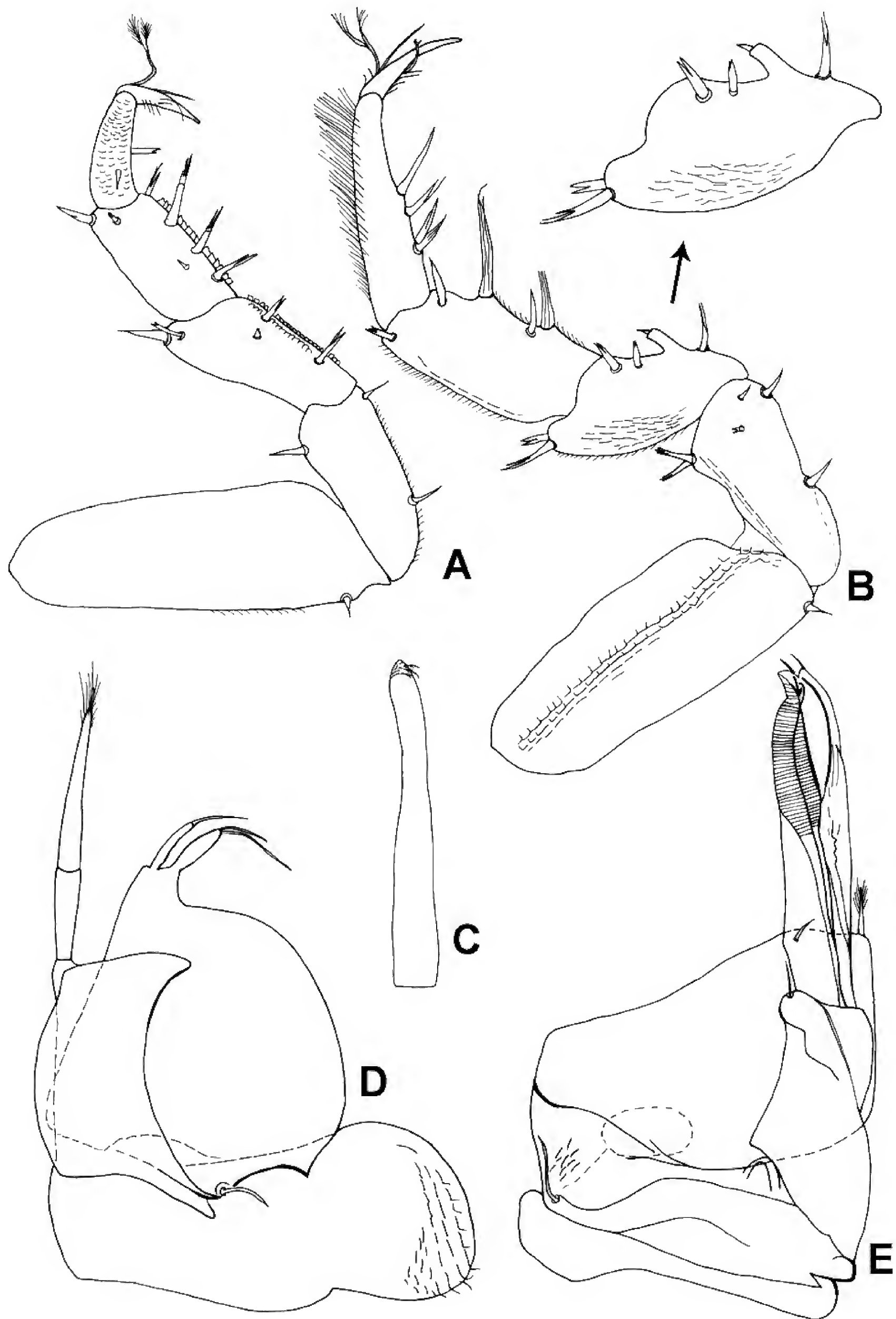
**Fig. 7.** *Trichonisoides sicoensis* Reboleira & Taiti sp. nov. from Gruta da Cerâmica, Sicó. — Paratype, ♀. A. Specimen in dorsal view. — Paratype, ♂. B. Dorsal scale-seta. C. Cephalon in frontal view. D. Cephalon in dorsal view. E. Pleonites 4, 5, telson and right uropod. F. Antennula. G. Antenna.

**Description**

Maximum size: ♂ 3.5 × 1.2 mm; ♀ 3.9 × 1.2 mm. Body colourless and slightly convex (Fig. 7A). Dorsum smooth, with scattered triangular scale-setae (Fig. 7B). Cephalon (Fig. 7C–D) with rounded frontal lateral lobes not protruding frontwards. Eyes absent. Pereonites 1–4 (Fig. 7A) with rounded posterior corners; pereonites 5–7 (Fig. 7A) with epimera pointing backwards. Pleon (Fig. 7A, E) narrower than pereon; pleonites 3–5 with small epimera and short posterior points. Telson (Fig. 7E) about three times as wide as long, with distal part trapezoidal with concave sides. Antennula (Fig. 7F) with three articles; third article with distinct spine and three long aesthetascs at apex. Antenna (Fig. 7G) with fifth article of peduncle shorter than flagellum; flagellum with five articles with two long aesthetascs on second article. Mandibles (Fig. 8A–B) with two penicils on the right and three on the left; molar process without penicils. Maxillula (Fig. 8C) with inner branch bearing three penicils at apex, inner one distinctly longer than other two; outer branch with 11 teeth and two thin stems. Maxilla (Fig. 8D) apically bilobed and setose, with outer lobe smaller than inner one; inner lobe with several long stout setae. Maxilliped (Fig. 8E) endite triangular, with stout triangular penicil at apex; palp distally rounded, long setae, and basal



**Fig. 8.** *Trichonisoides sicoensis* Reboleira & Taiti sp. nov. from Gruta da Cerâmica, Sicó, paratype, ♂. **A.** Right mandible. **B.** Left mandible. **C.** Maxillula. **D.** Maxilla. **E.** Maxilliped.



**Fig. 9.** *Trichonisoides sicoensis* Reboleira & Taiti sp. nov. from Gruta da Cerâmica, Sicó, paratype, ♂. A. Pereopod 1. B. Pereopod 7. C. Genital papilla. D. Pleopod 1. E. Pleopod 2.



article with two short compound setae. Uropod (Fig. 7E) with exopod distinctly longer than endopod and more distally inserted; exopod with several long, pointed setae and endopod with a long and a short seta at apex.

MALE. Pereopods 1 (Fig. 9A) to 3 with an area of short quadrangular scales on sternal margin of carpus and merus. Pereopod 7 (Fig. 9B) merus with distinct cylindrical lobe, with short seta at apex on mid-sternal margin. Genital papilla (Fig. 9C) fusiform. Pleopod 1 (Fig. 9D) exopod as long as wide, with broadly rounded outer margin and two unequal setae on distal lobe; endopod with basal article quadrangular with convex inner margin and concave outer margin, distal article fusiform with distinct suture in middle and setose apex. Pleopod 2 (Fig. 9E) exopod trapezoidal with large seta at apex; endopod biarticulated, distal article about 1.5 times as long as basal one, thickset, with two short triangular lobes and setae at apex.

### Remarks

This new species is tentatively included in the genus *Trichoniscoides* since it has all the characters of the genus, except for the distal article of the male pleopod 1 endopod, which shows a distinct circular suture in the middle, and the thickset distal part of the male pleopod 2 endopod. These characters are present also in an epigean species described by Gregory *et al.* (2012: 7, fig. 4) as “? *Trichoniscoides* species C” from Avión, valley of Río Valdeiras, Orense, north-western Spain, and Castanheira, Viana do Castelo, northern Portugal. The new species differs from the one recorded by Gregory *et al.* (2012) in the shape of the basal article of the male pleopod 1 endopod and of the distal part of the male pleopod 2 endopod. *Trichoniscoides sicoensis* Reboleira & Taiti sp. nov., together with the species recorded by Gregory *et al.* (2012), might belong to a distinct genus, but this can only be confirmed when other species with similar characters are found. For the presence of a lobe on the mid-sternal margin of the male pereopod 7 merus, the new species also resembles *T. broteroi*, from which it is distinguishable by the shape of the male pleopods 1 and 2. A hook-like lobe on the sternal margin of the male pereopod 7 merus is present also in the “aquitano-languedocien” group of species (*sensu* Vandel 1960a), but in the species of this group the lobe is near the base instead of being on the mid-part of the sternal margin.

### Ecological notes

This species seems to be endemic to caves of the Sicó karst area. In Gruta do Soprador do Carvalho one specimen was collected under a stone completely submerged in the cave stream. Despite the amphibian behaviour and submersion tolerance, this species is mostly found in the superficial parts of caves, where roots are abundant. Several troglotrophic species are known to share this habitat with *T. sicoensis* Reboleira & Taiti sp. nov.: the pseudoscorpions *Roncocreagris blothroides* (Beier, 1962), *R. borgesii* Zaragoza & Reboleira, 2013 and *R. cavernicola* Vachon, 1946; the millipede *Scutogona minor* Enghoff & Reboleira, 2013; the woodlice *T. broteroi*, *Miktoniscus longispina* Reboleira & Taiti sp. nov. and *Porcellio cavernicolus*; and the rove beetle *Domene lusitanica* Reboleira & Oromí, 2011 (Reboleira *et al.* 2011b, 2013b; Enghoff & Reboleira 2013a).

Genus *Metatrichoniscoides* Vandel, 1942

*Metatrichoniscoides salirensis* Reboleira & Taiti sp. nov.

[urn:lsid:zoobank.org:act:7E09D1C5-19F8-44DF-A1AE-B2D741C411AE](https://zoobank.org/act:7E09D1C5-19F8-44DF-A1AE-B2D741C411AE)

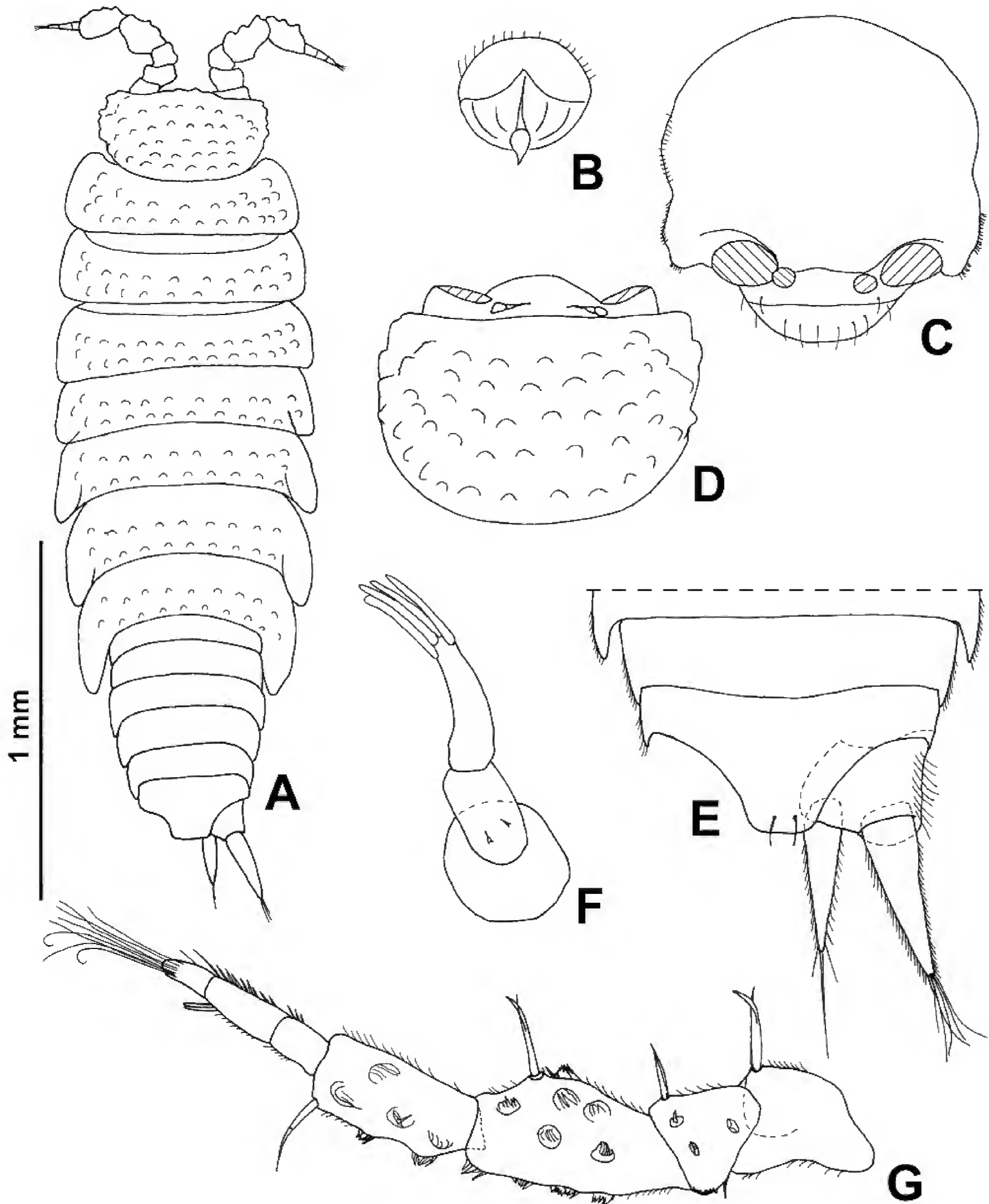
Figs 10A–G, 11A–E, 12A–E

### Diagnosis

A blind and colourless *Metatrichoniscoides* characterised by the male pleopod 1 exopod having two long distal setae subequal in length, and the male pleopod 2 endopod having a thickset distal article, ending in a thinner sinuous part with a beak-like small lobe medially directed.

### Etymology

The new species is named after Gruta de Salir, the cave where the specimens were collected, in the municipality of Caldas da Rainha.



**Fig. 10.** *Metatrichoniscoides salirensis* Reboleira & Taiti sp. nov. from Gruta de Salir, Caldas da Rainha typhonic valley. — Paratype, ♀. **A.** Adult specimen in dorsal view. **B.** Dorsal scale-seta. **C.** Cephalon in frontal view. **D.** Cephalon in dorsal view. — Paratype, ♂. **E.** Pleonites 4, 5, telson and right uropod. **F.** Antennula. **G.** Antenna.

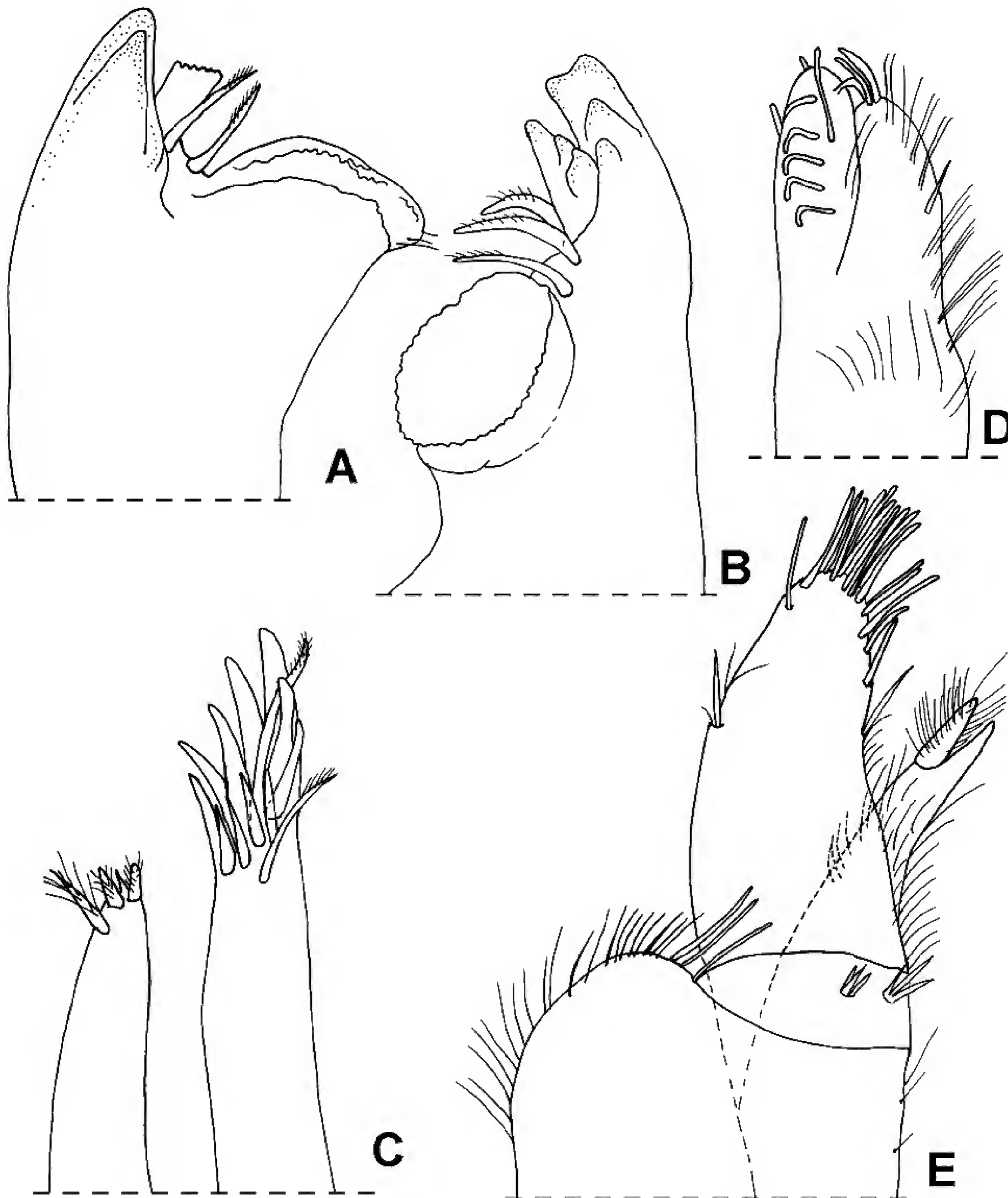
**Material examined**

**Holotype**

PORTUGAL: ♂, Gruta de Salir, Salir do Porto, Caldas da Rainha, 26 Dec. 2012 (MZUF).

**Paratypes**

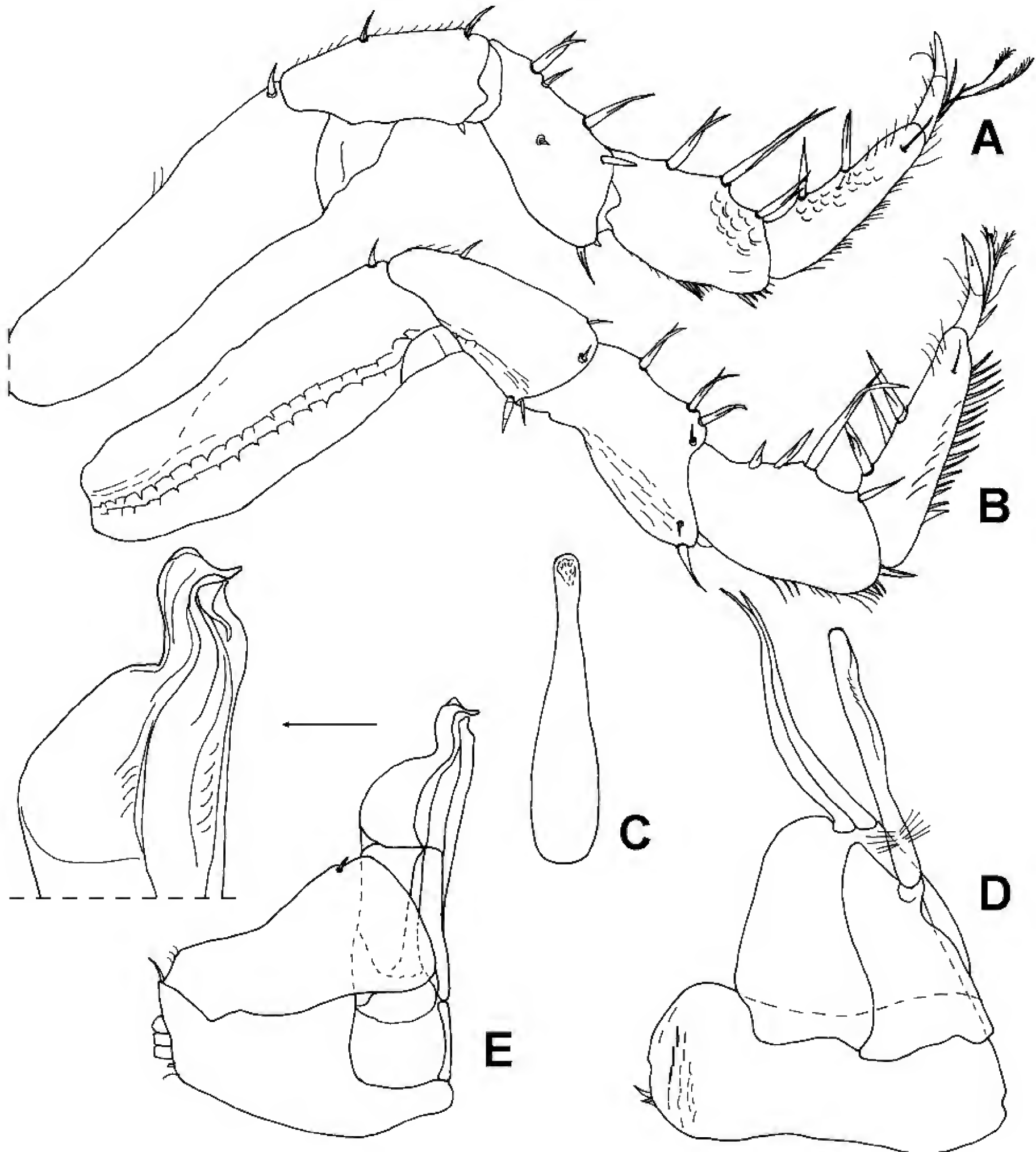
PORTUGAL: 1 ♂, 2 ♀♀, same data as holotype (MZUF); 1 ♂, 2 ♀♀, same data as holotype (SR).



**Fig. 11.** *Metatriconiscoides salirensis* Reboleira & Taiti sp. nov. from Gruta de Salir, Caldas da Rainha, paratype, ♂. **A.** Right mandible. **B.** Left mandible. **C.** Maxillula. **D.** Maxilla. **E.** Maxilliped.

### Description

Maximum size: ♂ and ♀ 2.2×0.8 mm. Body colourless, elongated and slightly convex (Fig. 10A). Cephalon and pereon with granulated dorsal surface; granules on pereonites arranged in double rows; each granule bearing a triangular scale-seta (Fig. 10B). Cephalon (Fig. 10C–D) with no frontal lateral lobes. Eyes absent. Pereonites 1–4 (Fig. 10A) with rounded posterior corners; pereonites 5–7 (Fig. 10A) with epimera directed backwards. Pleon (Fig. 10A,E) narrower than pereon; pleonites 3–5 with small epimera and short posterior points. Telson (Fig. 10E) twice as wide as long, with distal part trapezoidal with concave sides. Antennula (Fig. 10F) with three articles; third article distinctly longer than first



**Fig. 12.** *Metatrichoniscoides salirensis* Reboleira & Taiti sp. nov. from Gruta de Salir, Caldas da Rainha, paratype, ♂. **A.** Pereopod 1. **B.** Pereopod 7. **C.** Genital papilla. **D.** Pleopod 1. **E.** Pleopod 2.

and second and bearing four long aesthetascs at apex. Antenna (Fig. 10G) with fifth article of peduncle slightly shorter than flagellum; flagellum with three articles, with two aesthetascs on second article. Mandibles (Fig. 11A–B) with two penicils on the right and three on the left; molar process without penicils. Maxillula (Fig. 11C) with inner branch bearing three short penicils at apex; outer branch with 11 teeth and two thin stems. Maxilla (Fig. 11D) apically bilobed, with outer lobe shorter than inner one; inner lobe with some long, stout setae near medial margin. Maxilliped (Fig. 11E) endite triangular, ending with triangular point and subapical penicil; palp distally rounded, with long setae, and basal article with two short compound setae. Uropod (Fig. 10E) with exopod slightly longer than endopod; exopod with several long, pointed setae and endopod with long seta at apex.

MALE. Pereopod 1 (Fig. 12A) and pereopod 7 (Fig. 12B) with no peculiar modifications. Genital papilla (Fig. 12C) fusiform, with rounded apex. Pleopod 1 (Fig. 12D) exopod as long as wide, with broadly rounded apical margin bearing two long setae of equal length; endopod with basal article triangular, baton-like distal article inserted on medial margin of basal article. Pleopod 2 (Fig. 12E) exopod trapezoidal, with short seta at apex; endopod biarticulated, distal article thickset, ending in thinner sinuous part with beak-like small lobe medially directed.

### Remarks

Until now the genus *Metatrichoniscoides* included only four species (Schmalfuss 2003): *M. leydigii* (Weber, 1880) from western France, Belgium, the Netherlands, western Germany and greenhouses in the Czech Republic, Sweden and Finland; *M. nemausiensis* Vandel, 1942 and *M. fouresi* Vandel, 1950 from France; and *M. celticus* Oliver & Trew, 1981 from Wales (Vandel 1942; Oliver & Trew 1981). *Metatrichoniscoides salirensis* Reboleira & Taiti sp. nov. is readily distinguished from all the other species in the genus by the male pleopod 1 exopod bearing two long setae and the peculiar shape of the male pleopod 2 endopod. This represents the first record of the genus for Portugal and the Iberian Peninsula.

### Ecological notes

Gruta de Salir is a peculiar, beautiful cave located near the sea, with a genesis related to previous sea levels, evidenced by the presence of marine sand in the lowest parts. This is the first troglotrophic species known from this cave and this karst area.

Genus *Troglonethes* Cruz, 1989

*Troglonethes olissipoensis* Reboleira & Taiti sp. nov.

[urn:lsid:zoobank.org:act:7E09D1C5-19F8-44DF-A1AE-B2D741C411AE](https://zoobank.org/act:7E09D1C5-19F8-44DF-A1AE-B2D741C411AE)

Figs 13A–G, 14A–E, 15A–D

### Diagnosis

A species of *Troglonethes* characterised by the antenna having five flagellar articles, the male pleopod 1 exopod triangular, as wide as long, and the male pleopod 2 endopod with the distal article bearing a basal and a distal hook-like process.

### Etymology

The new species is named after Olissipo, the old name of Lisbon, on the peninsula of which the Gruta de Alvide is located.

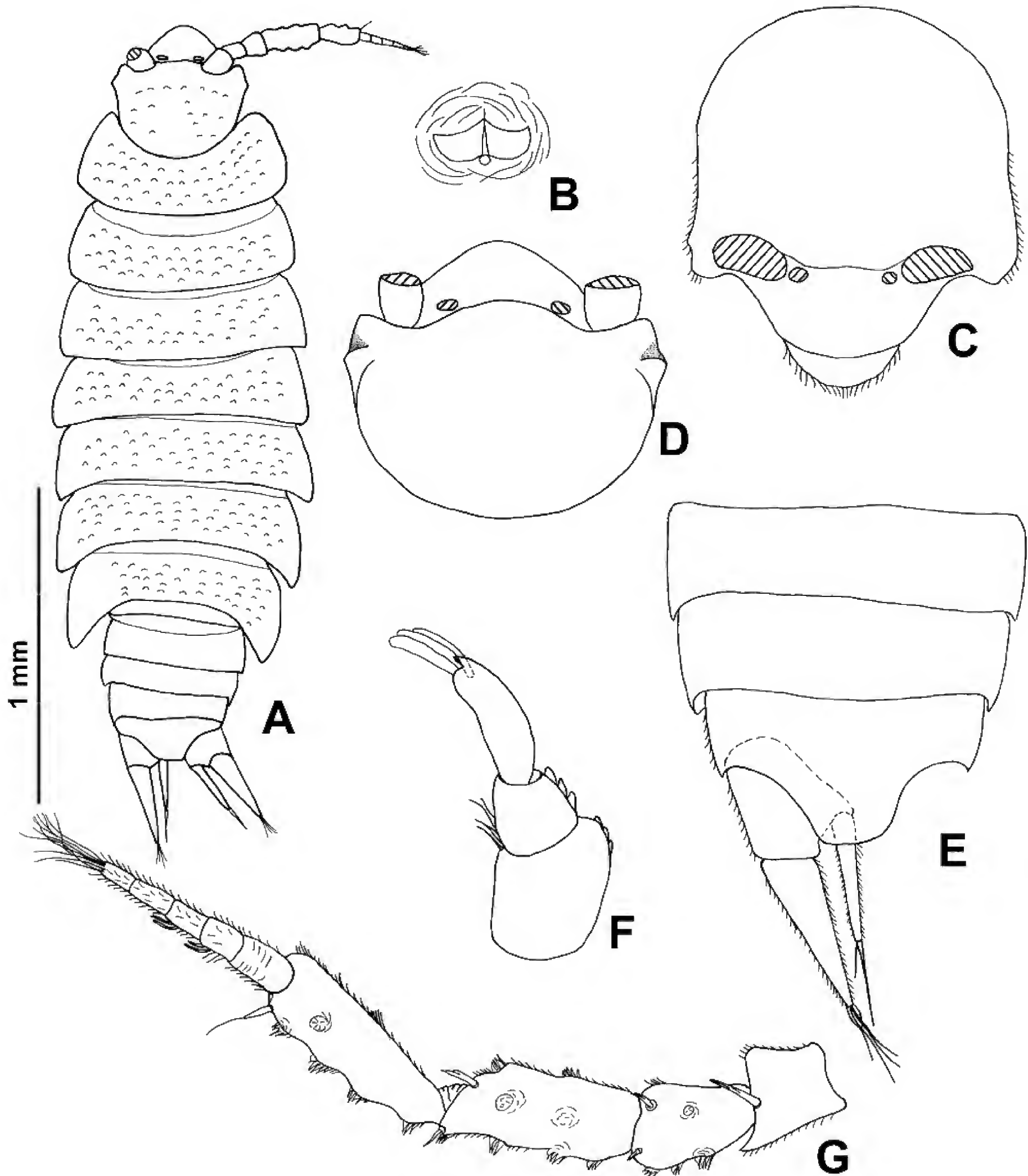
### Material examined

#### Holotype

PORTUGAL: ♂, Gruta da Alvide, Cascais, Lisbon Peninsula, 26 Dec. 2009 (MZUF).

**Paratypes**

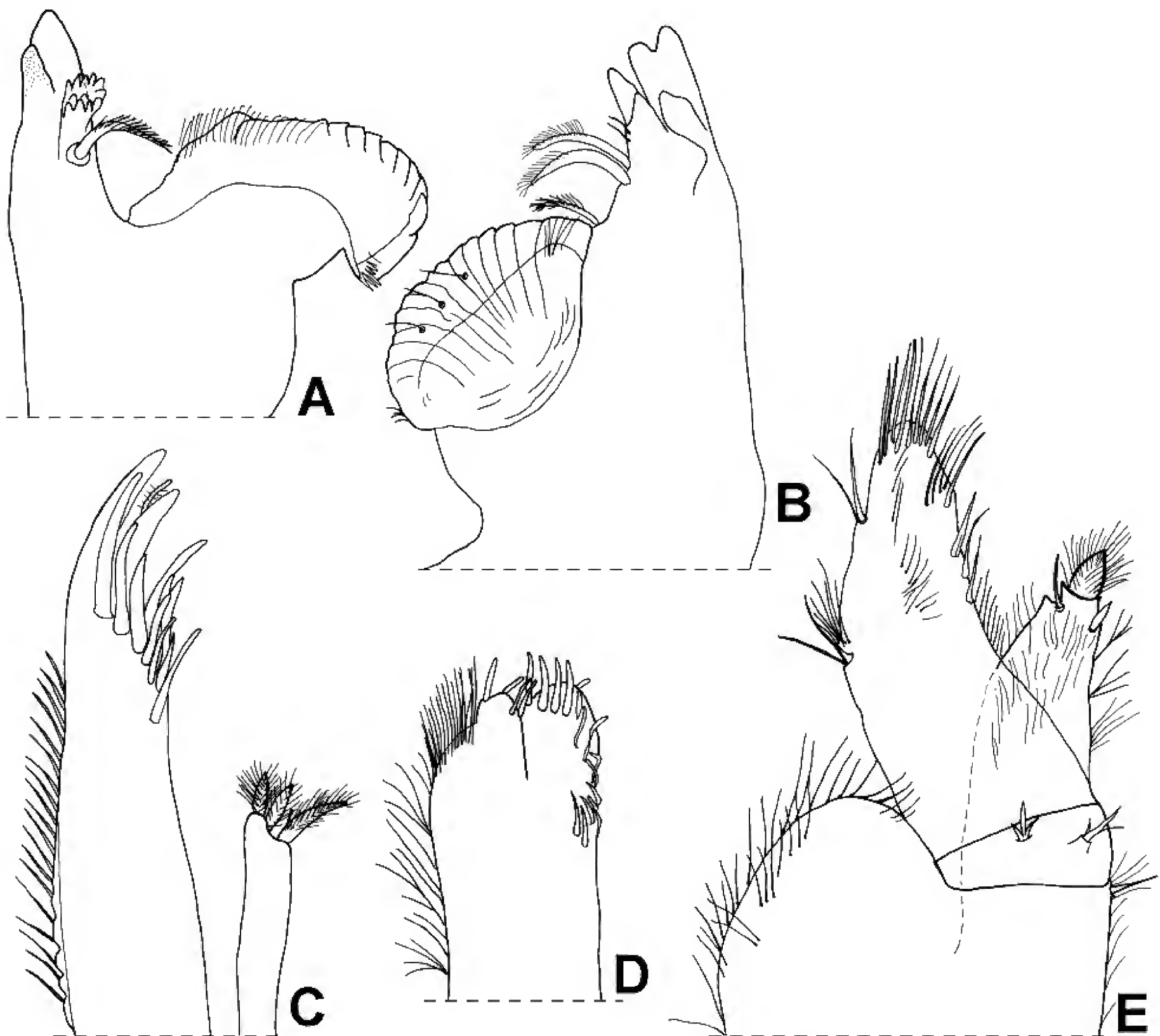
PORTUGAL: 5 ♂♂, 2 ♀♀, 3 juvs, same data as holotype (MZUF); 5 ♂♂, 2 ♀♀, same data as holotype (SR); 5 ♂♂, 2 ♀♀, same data as holotype (ZMUC).



**Fig. 13.** *Troglonethes olissipoensis* Reboleira & Taiti sp. nov. from Gruta de Alvide, Lisbon Peninsula. — Paratype, ♀. **A.** Adult specimen in dorsal view. — Paratype, ♂. **B.** Dorsal scale-seta. **C.** Cephalon in frontal view. **D.** Cephalon in dorsal view. **E.** Pleonites 4, 5, telson and left uropod. **F.** Antennula. **G.** Antenna.

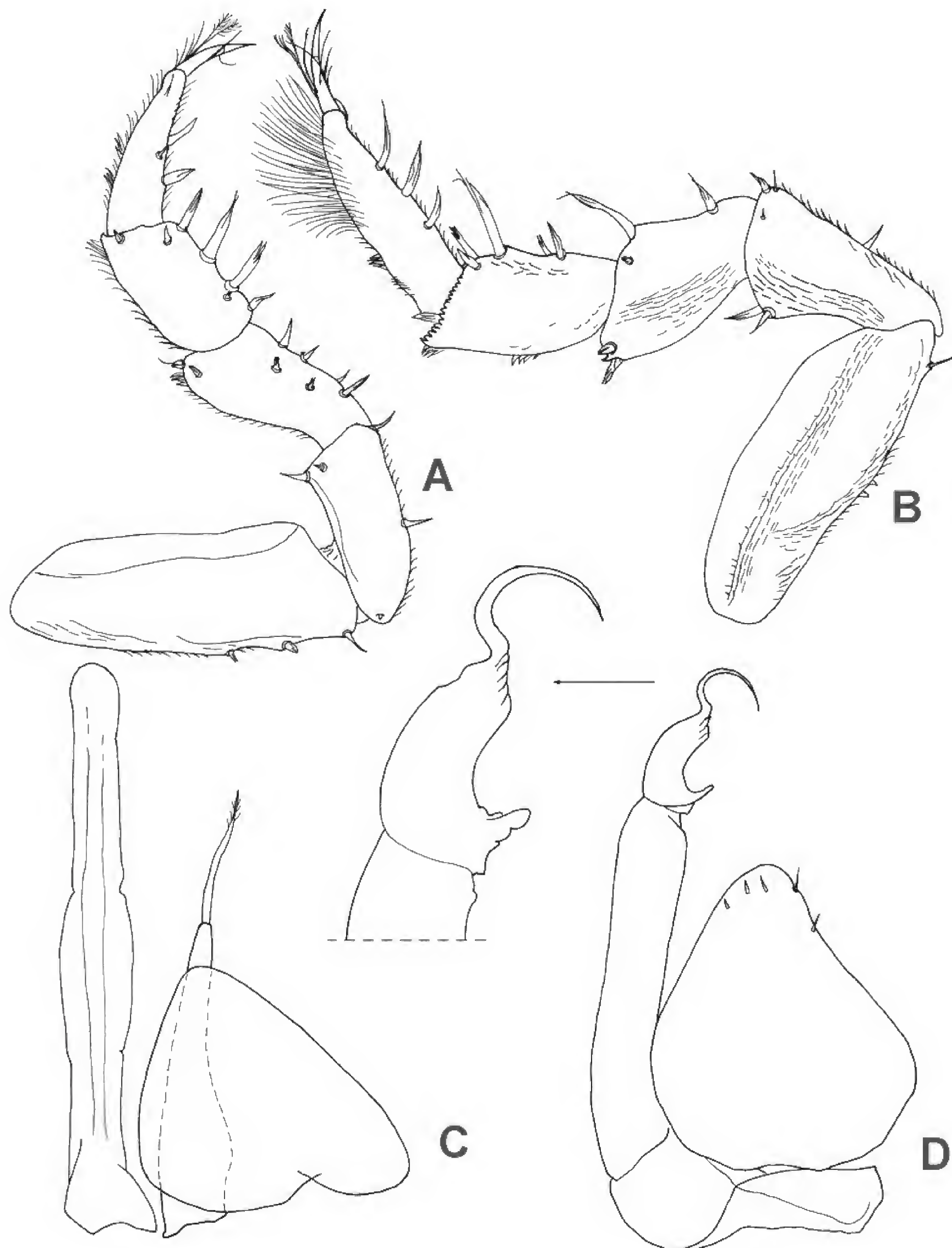
**Description**

Maximum size: ♂ 3.5 × 0.8 mm; ♀ 4.2 × 1.2 mm. Body colourless and elongated (Fig. 13A). Dorsum of cephalon and pereon granulated; each granule equipped with a triangular scale-seta (Fig. 13B); pleon and telson smooth. Cephalon (Fig. 13C–D) with quadrangular frontal lateral lobes slightly protruding outwards. Eyes absent. Pereonites 1–4 (Fig. 13A) with rounded posterior corners; pereonites 5–7 (Fig. 13A) with epimera pointing backwards. Pleon (Fig. 13A, E) narrower than pereon; pleonites 3–5 with small epimera and very short posterior points. Telson (Fig. 13E) about twice as wide as long, with distal part trapezoidal with concave sides. Antennula (Fig. 13F) with three articles; third article with spine and three long aesthetascs at apex. Antenna (Fig. 13G) with third, fourth and fifth article of peduncle with distinct tubercles bearing scale-setae; fifth article as long as flagellum; flagellum with five articles, with two long aesthetascs on second and third article. Mandibles (Fig. 14A–B) with one penicil on the right and three on the left. Maxillula (Fig. 14C) with inner branch bearing three penicils at apex, inner one distinctly longer than other two; outer branch with 12 teeth and thin, setose stem among outer group of teeth. Maxilla (Fig. 14D) apically bilobed and setose, with outer and inner lobes subequal; inner lobe with several long stout setae along margin. Maxilliped (Fig. 14E) endite triangular, with stout triangular



**Fig. 14.** *Troglonethes olissipoensis* Reboleira & Taiti sp. nov. from Gruta de Alvide, Lisbon Peninsula, paratype, ♂. **A.** Right mandible. **B.** Left mandible. **C.** Maxillula. **D.** Maxilla. **E.** Maxilliped.

penicil at apex; palp distally rounded, with long setae, basal article with two short, compound setae. Uropod (Fig. 13E) with exopod slightly longer than endopod and more distally inserted; exopod with several long pointed setae and endopod with a long and a short seta at apex.



**Fig. 15.** *Troglonethes olissipoensis* Reboleira & Taiti sp. nov. from Gruta de Alvide, Lisbon Peninsula, paratype, ♂. **A.** Pereopod 1. **B.** Pereopod 7. **C.** Genital papilla and pleopod 1. **D.** Pleopod 2.



MALE. Pereopod 1 (Fig. 15A) with no particular modifications. Pereopod 7 (Fig. 15B) ischium with straight sternal margin, carpus with row of scales on distal margin, and propodus with long, thin setae on distal half of tergal margin. Genital papilla (Fig. 15C) fusiform, with rounded apex, much longer than pleopod 1. Pleopod 1 (Fig. 15C) exopod triangular, as wide as long, with broadly rounded apex; endopod with basal article elongated, longer than exopod, with sinuous outer margin, distal article flagelliform with setose apex. Pleopod 2 (Fig. 15D) exopod triangular, with broadly rounded apex with few short setae; endopod biarticulated, basal article about three times as long as distal one, with parallel sides, distal article with outer margin bearing hook-like process at base and one at apex.

### Remarks

The genus *Troglonethes* was erected by Cruz (1989) for the new species *T. aurouxi* from a cave north of Valencia, Spain. Tabacaru (1993) included the genus in the tribe Speleonethini. The new species from Portugal is included in the genus since it has all the characters listed in the diagnosis. *Troglonethes olissipoensis* Reboleira & Taiti sp. nov. differs from *T. aurouxi* in having an antennal flagellum with five, instead of four, articles, the male pleopod 1 exopod shorter than the basal article of the endopod, and the male pleopod 2 endopod with a basal hook-like process on the outer margin of the distal article.

### Ecological notes

This species was only found in Gruta de Alvide, located in an overurbanized area, with part of the cave ceiling used as the base of a residential building. The specimens were collected in the deepest parts of the cave, the so-called third level. It is the second troglolithic species from karst caves in the Lisbon Peninsula, after the record of the bristletail *Coletinia* sp. in Gruta de Colaride (Reboleira *et al.* 2012a). Unidentified springtails and blaniulid millipedes were also collected.

### *Troglonethes arrabidaensis* Reboleira & Taiti sp. nov.

[urn:lsid:zoobank.org:act:78A12550-F7CA-4892-9E90-7F85446423D3](https://zoobank.org/act:78A12550-F7CA-4892-9E90-7F85446423D3)

Figs 16A–G, 17A–D

### Diagnosis

A species of *Troglonethes* characterised by the antenna having three flagellar articles, the male pereopod 7 carpus enlarged in the basal part, the pleopod 1 exopod triangular, as wide as long, and the male pleopod 2 endopod with the distal article bearing an apical hook-like process.

### Etymology

The new species is named after the type locality, the Arrábida karst massif.

### Material examined

#### Holotype

PORTUGAL: ♂, Gruta do Frade, Arrábida Massif, 16 Aug. 2013 (MZUF).

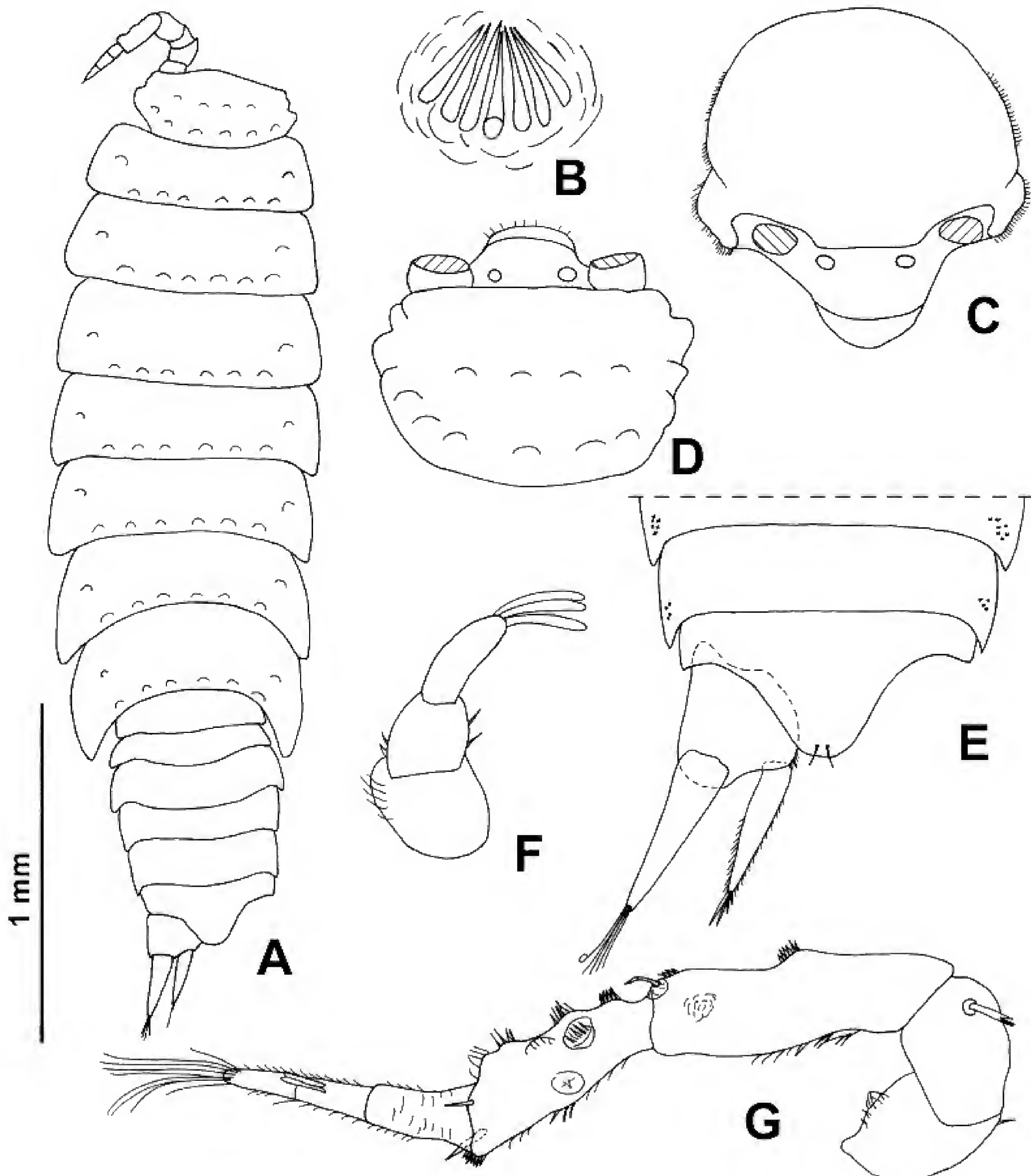
#### Paratypes

PORTUGAL: 3 ♂♂, 13 ♀♀, same data as holotype (MZUF, SR and ZMUC).

### Description

Maximum size: ♂ and ♀ 2.7 × 0.8 mm. Body colourless and elongated (Fig. 16A). Dorsum of cephalon and pereonites with two rows and one row of large granules, respectively; each granule with a scale-seta (Fig. 16B); pleon and telson smooth. Cephalon (Fig. 16C–D) with short, quadrangular frontal lateral lobes. Eyes absent. Pereonites 1–3 with rounded posterior corners; pereonites 4–7 with epimera pointing backwards (Fig. 16A). Pleon (Fig. 16A, E) slightly narrower than pereon; pleonites 3–5 with small

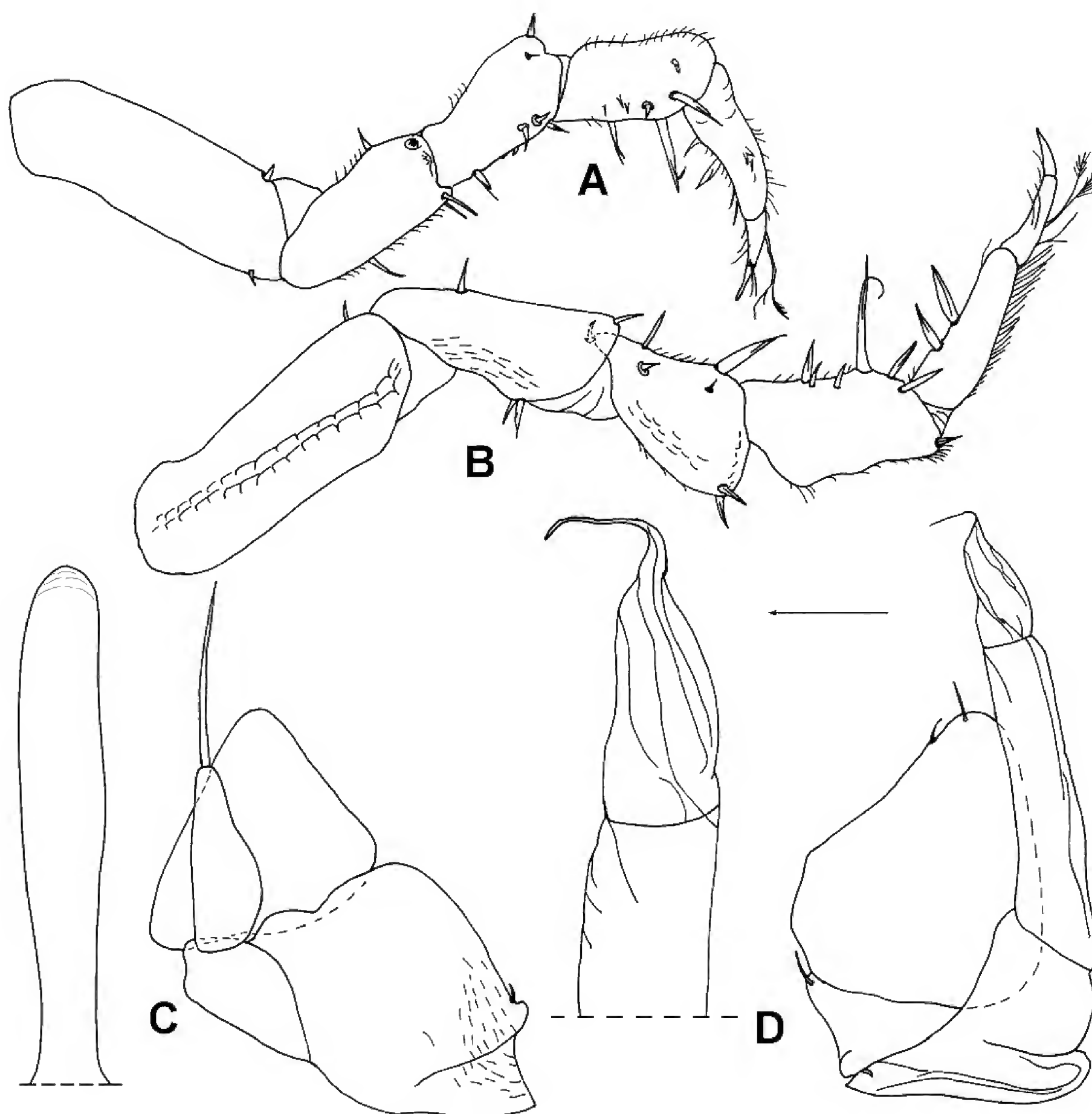
epimera and very short posterior points. Telson (Fig. 16E) about twice as wide as long, with distal part trapezoidal, with concave sides and broadly rounded apex. Antennula (Fig. 16F) with three articles; third article with three long aesthetascs at apex. Antenna (Fig. 16G) with fourth and fifth article of peduncle with distinct tubercles bearing scale-setae; fifth article slightly shorter than flagellum; flagellum with



**Fig. 16.** *Troglonethes arrabidaensis* Reboleira & Taiti sp. nov. from Gruta do Frade, Arrábida. — Paratype, ♀. **A.** Adult specimen in dorsal view. **B.** Dorsal scale-seta. **C.** Cephalon in frontal view. **D.** Cephalon in dorsal view. **E.** Pleonites 4, 5, telson and left uropod. — Paratype, ♂. **F.** Antennula. **G.** Antenna.

three articles, with two long aesthetascs on second article. Buccal pieces as in previous species. Uropod (Fig. 16E) with exopod slightly longer than endopod, exopod and endopod inserted at same level.

MALE. Pereopod 1 (Fig. 17A) with no particular modifications. Pereopod 7 (Fig. 17B) ischium with straight sternal margin, carpus enlarged in basal part. Genital papilla (Fig. 17C) fusiform, with rounded apex, much longer than pleopod 1. Pleopod 1 (Fig. 17C) exopod triangular, as wide as long, with broadly rounded apex; endopod with basal article elongated, shorter than exopod, with sinuous outer margin, distal article flagelliform. Pleopod 2 (Fig. 17D) exopod triangular, with broadly rounded apex with few short setae; endopod biarticulated, basal article more than twice as long as distal one, with parallel sides, distal article with hook-like process at apex.



**Fig. 17.** *Troglonethes arrabidaensis* Reboleira & Taiti sp. nov. from Gruta do Frade, Arrábida, paratype, ♂. **A.** Pereopod 1. **B.** Pereopod 7. **C.** Genital papilla and pleopod 1. **D.** Pleopod 2.

### Remarks

The new species is very similar to *Troglonethes aurouxi* in the dorsal granulation and shape of the male pleopod 2. It differs in having the antennal flagellum with three, instead of four, articles, and a wider male pleopod 1 exopod. It is readily distinguishable from *T. olissipoensis* Reboleira & Taiti sp. nov. in the larger and less numerous dorsal granules, the enlarged basal part of the male pereopod 7 carpus, the male pleopod 1 endopod with the basal article shorter than the exopod, and the distal article of the male pleopod 2 endopod lacking the hook-like process at the base.

### Ecological notes

This species was only found in the Gruta do Frade in the Arrábida Massif. The cave entrance is by the seashore and there are several anchialine lakes inside, influenced by the sea tides. It is the first record of troglolithic terrestrial isopods in Arrábida.

Genus *Miktoniscus* Kesselyák, 1930

*Miktoniscus longispina* Reboleira & Taiti sp. nov.

[urn:lsid:zoobank.org:act:6B9A5E8B-53F8-408D-B3BA-8E10BCE20717](https://zoobank.org/urn:lsid:zoobank.org:act:6B9A5E8B-53F8-408D-B3BA-8E10BCE20717)

Figs 18A–F, 19A–E, 20A–D

### Diagnosis

A species of *Miktoniscus* characterised by a depigmented body, the male pereopod 7 having a long and stout seta on the distal corner of the ischium, and a triangular male pleopod 1 exopod.

### Etymology

From Latin *longus* = long + *spina* = spine. The name of the new species refers to the long, thick seta on the distal part of the male pereopod 7.

### Material examined

#### Holotype

PORTUGAL: ♂, Gruta dos Bolhos, Cesaredas Plateau, 26 Dec. 2010 (MZUF).

#### Paratype

PORTUGAL: 1 ♀, same locality as holotype, Feb. 2009 (MZUF).

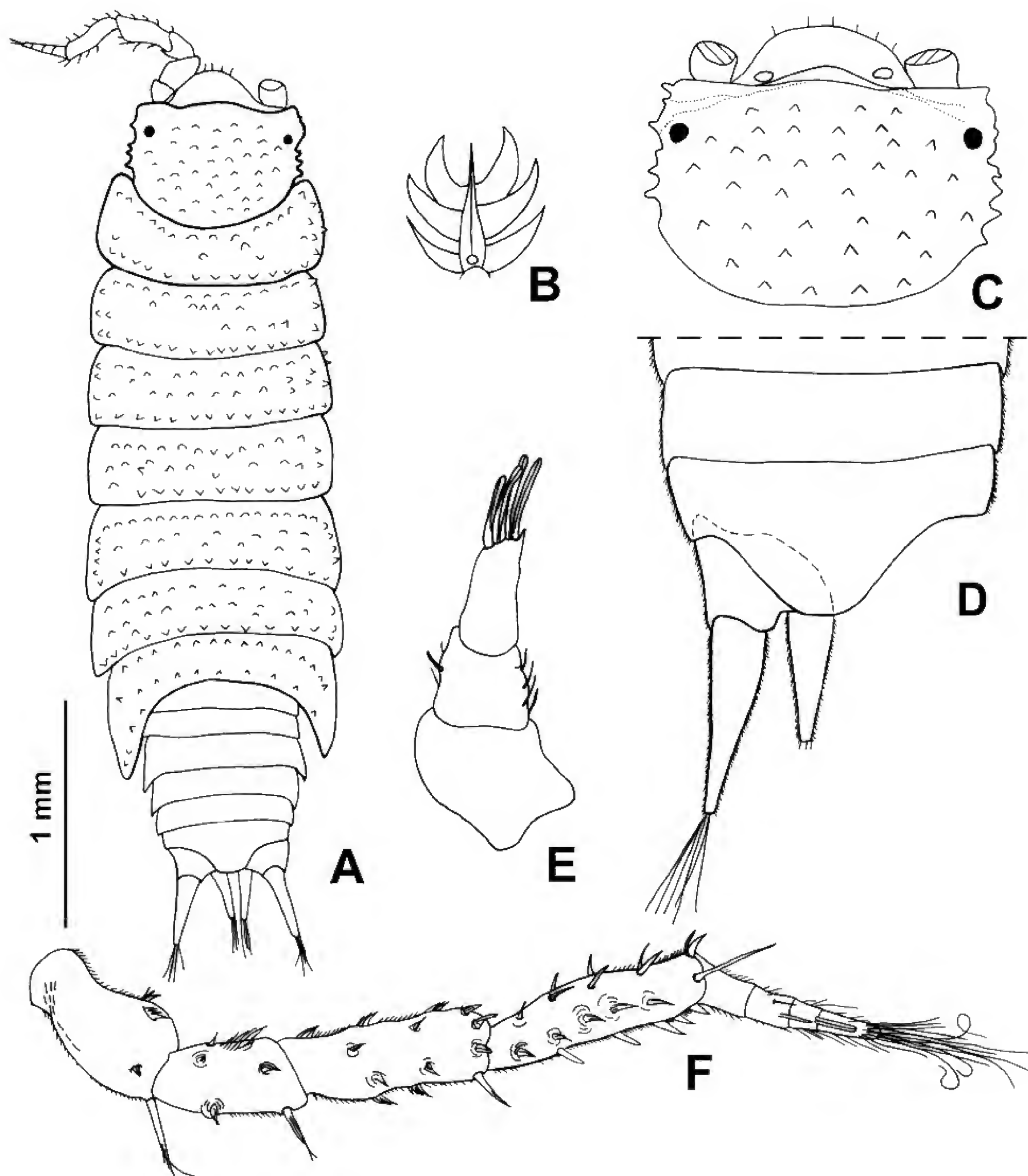
#### Additional material

PORTUGAL: 1 ♂, 2 ♀♀, Gruta da Cerâmica, Sicó Massif, 10 Jun. 2011 (MZUF); 2 ♂♂, 3 ♀♀, same locality, 2 Mar. 2013 (SR); 1 ♂, 1 ♀, Algar da Ervilha, Sicó, 30 Mar. 2014 (ZMUC).

### Description

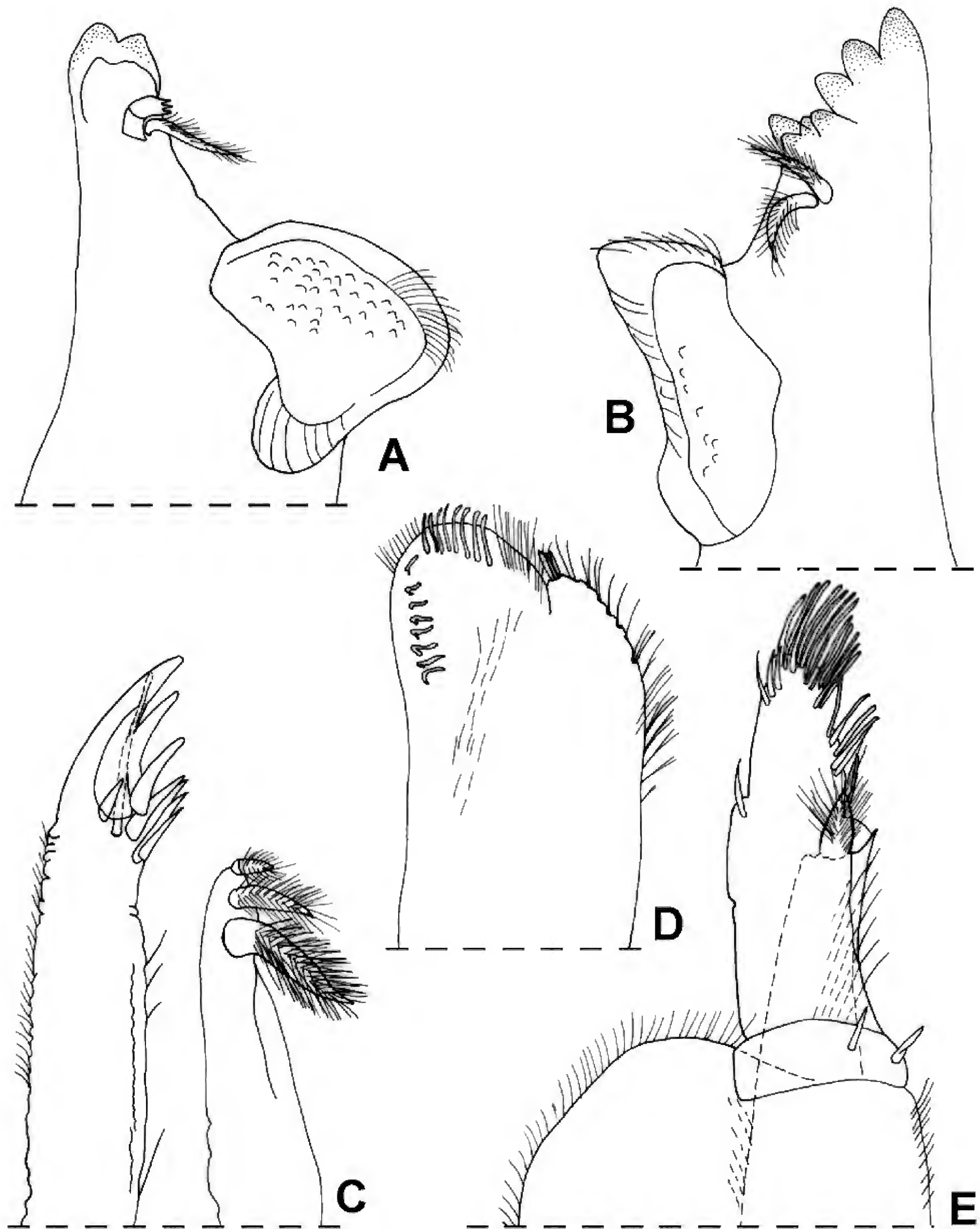
Maximum size: ♂ and ♀ 3.5 × 1.0 mm. Body depigmented, elongated (Fig. 18A). Dorsum of cephalon and pereon distinctly granulated, each granule bearing a scale-seta on top (Fig. 18B). Cephalon (Fig. 18C) with no frontal lobes. Eye consisting of single black ocellus (lacking in specimens from Gruta da Cerâmica and Algar da Ervilha). Pereonites 1–4 with rounded posterior corners; pereonites 5–7 with epimera pointing backwards (Fig. 18A). Pleon (Fig. 18A, D) slightly narrower than pereon; pleonites 3–5 with reduced epimera and very short posterior points. Telson (Fig. 18D) about twice as wide as long, with rectangular basal part and trapezoidal distal part, with almost straight sides. Antennula (Fig. 18E) with three articles; third article with short spine and four long aesthetascs at apex (five in specimens from Gruta da Cerâmica and Algar da Ervilha). Antenna (Fig. 18F) with fifth article of peduncle slightly longer than flagellum; flagellum with four articles, with one aesthetasc on second article and two

aesthetascs on third article (two and four, respectively, in specimens from Gruta da Cerâmica and Algar da Ervilha). Mandibles (Fig. 19A–B) with one penicil on the right and two on the left; molar process without penicils. Maxillula (Fig. 19C) with inner branch bearing three penicils at apex, diminishing in size from proximal to distal; outer branch with nine teeth and thin stem. Maxilla (Fig. 19D) apically bilobed, outer lobe smaller and shorter than inner one; inner lobe with line of several long, stout setae near apical and inner margins. Maxilliped (Fig. 19E) endite triangular, with stout triangular penicil at



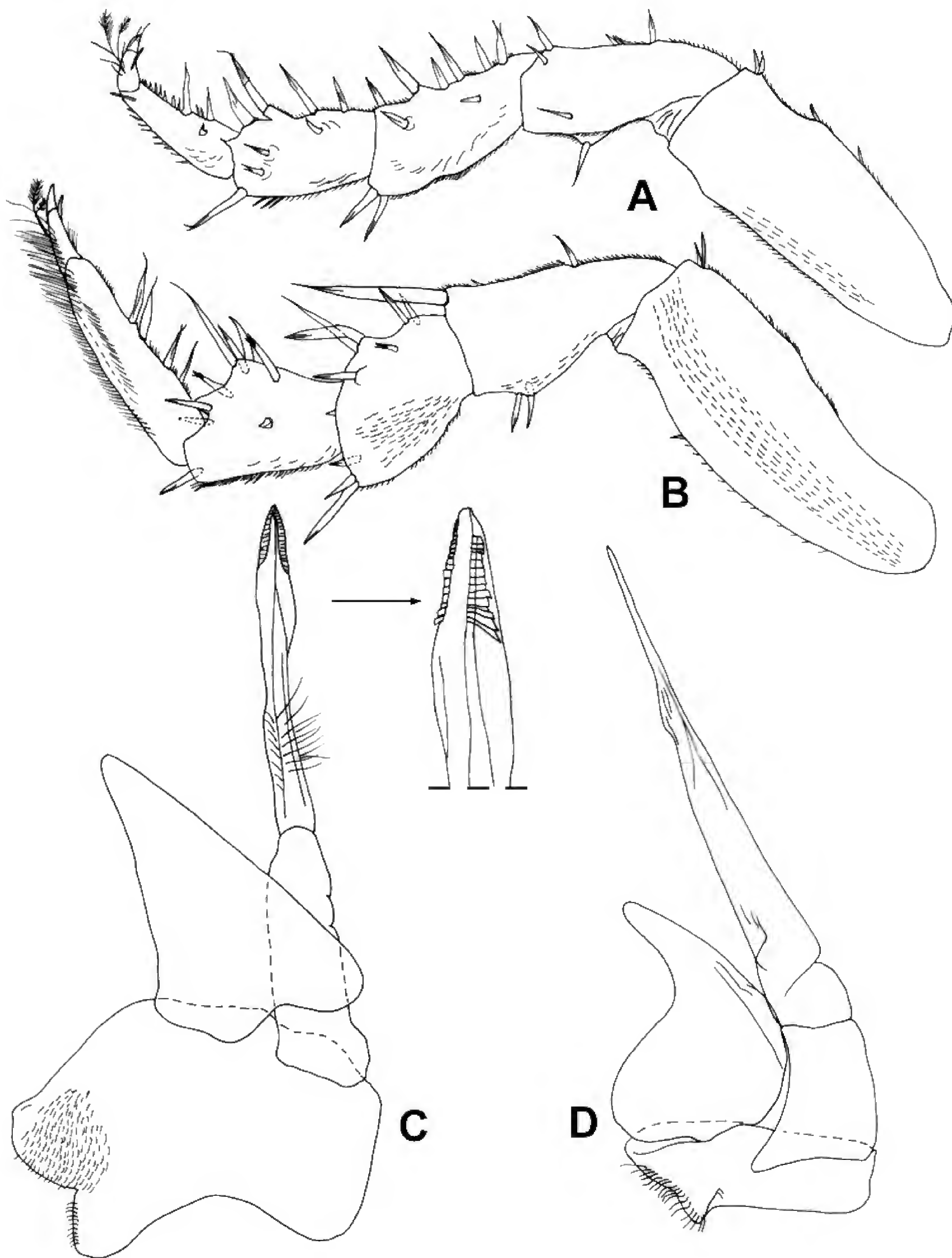
**Fig. 18.** *Miktoniscus longispina* Reboleira & Taiti sp. nov. from Gruta dos Bolhos, Cesaredas Plateau. — Paratype, ♀. **A.** Specimen in dorsal view. — Paratype, ♂. **B.** Dorsal scale-seta. **C.** Cephalon in dorsal view. **D.** Pleonite 5, telson and left uropod. **E.** Antennula. **F.** Antenna.

apex; palp elongated, with long setae on margin of apical part, and basal article with two short, simple setae. Uropod (Fig. 18E) with exopod distinctly longer than endopod and more distally inserted.



**Fig. 19.** *Miktoniscus longispina* Reboleira & Taiti sp. nov. from Gruta dos Bolhos, Cesaredas Plateau, paratype, ♂. **A.** Right mandible. **B.** Left mandible. **C.** Maxillula. **D.** Maxilla. **E.** Maxilliped.

MALE. Pereopod 1 (Fig. 20A) with no distinct sexual modifications. Pereopod 7 (Fig. 20B) ischium triangular, with strong seta, as long as merus, at corner between distal and sternal margin; sternal margin of merus sinuous, with one recurved seta and one pointed seta in the middle; carpus with distal part enlarged, with some strong setae on sternal margin. Pleopod 1 (Fig. 20C) exopod triangular, about



**Fig. 20.** *Miktoniscus longispina* Reboleira & Taiti sp. nov. from Gruta dos Bolhos, Cesaredas Plateau, paratype, ♂. **A.** Pereopod 1. **B.** Pereopod 7. **C.** Pleopod 1. **D.** Pleopod 2.

twice as long as wide; endopod with basal article distinctly shorter than distal article, which is slightly enlarged subapically, with triangular and crenulated apical part. Pleopod 2 (Fig. 20D) exopod triangular, with distinctly concave outer margin; endopod biarticulated, distal article fusiform, elongated, about four times as long as first article.

### Remarks

At present, the genus *Miktoniscus* includes 15 species distributed in the Americas and Western Europe, including the Atlantic islands (Schmalfuss 2003). The new species is readily distinguishable from all species in the genus by the presence of a strong and long seta at the distal corner of the male pereopod 7 ischium. In continental Portugal and northwestern Spain only one species was previously known, *Miktoniscis bisetosus* Vandel, 1946, from which *M. longispina* Reboleira & Taiti sp. nov. also differs in lacking a recurved seta on the male pereopod 7 carpus and in having the male pleopod 1 exopod with an acute, rather than broadly rounded, apex. The new species occurs in two distinct massifs of central Portugal, on the west border of Cesaredas Plateau near the Atlantic coast, and in Gruta da Cerâmica and Algar da Ervilha in the centre of Sicó Massif. Some differences are present in the specimens from Sicó compared with the type specimens from Cesaredas, i.e., the lack of visible eyes and the different number of aesthetascs on the antennula and antennal flagellum. For this reason, we have not designated the additional material as paratypes. However, since the male characters are the same in all these populations, we consider them as belonging to the same species.

Genus *Haplophthalmus* Schöbl, 1860

*Haplophthalmus siculus* Dollfus, 1896

*Haplophthalmus siculus* Dollfus, 1896: 5, fig. 3.

*Haplophthalmus siculus* – Vandel 1946: 192, figs 36–41.

### Records

Cova da Adiça, Moura; Gruta do Algar, Mexilhoeirinha, Lagoa (Vandel 1946).

### Distribution

Portugal, Spain, southern Italy and Sicily.

Genus *Moserius* Strouhal, 1940

*Moserius inexpectatus* Reboleira & Taiti sp. nov.

[urn:lsid:zoobank.org:act:18B5B016-F7A6-4047-A2CB-28B4394797CF](https://zoobank.org/act:18B5B016-F7A6-4047-A2CB-28B4394797CF)

Figs 21A–E, 22A–C

### Diagnosis

A species of *Moserius* characterised by the male pereopod 7 carpus having a distal lobe on the sternal margin, and the pleopod 1 exopod having a truncate and sinuous distal point.

### Etymology

From Latin *inexpectatus* = unexpected. The name refers to the location, which is far from the previously known distribution range of the genus.

### Material examined

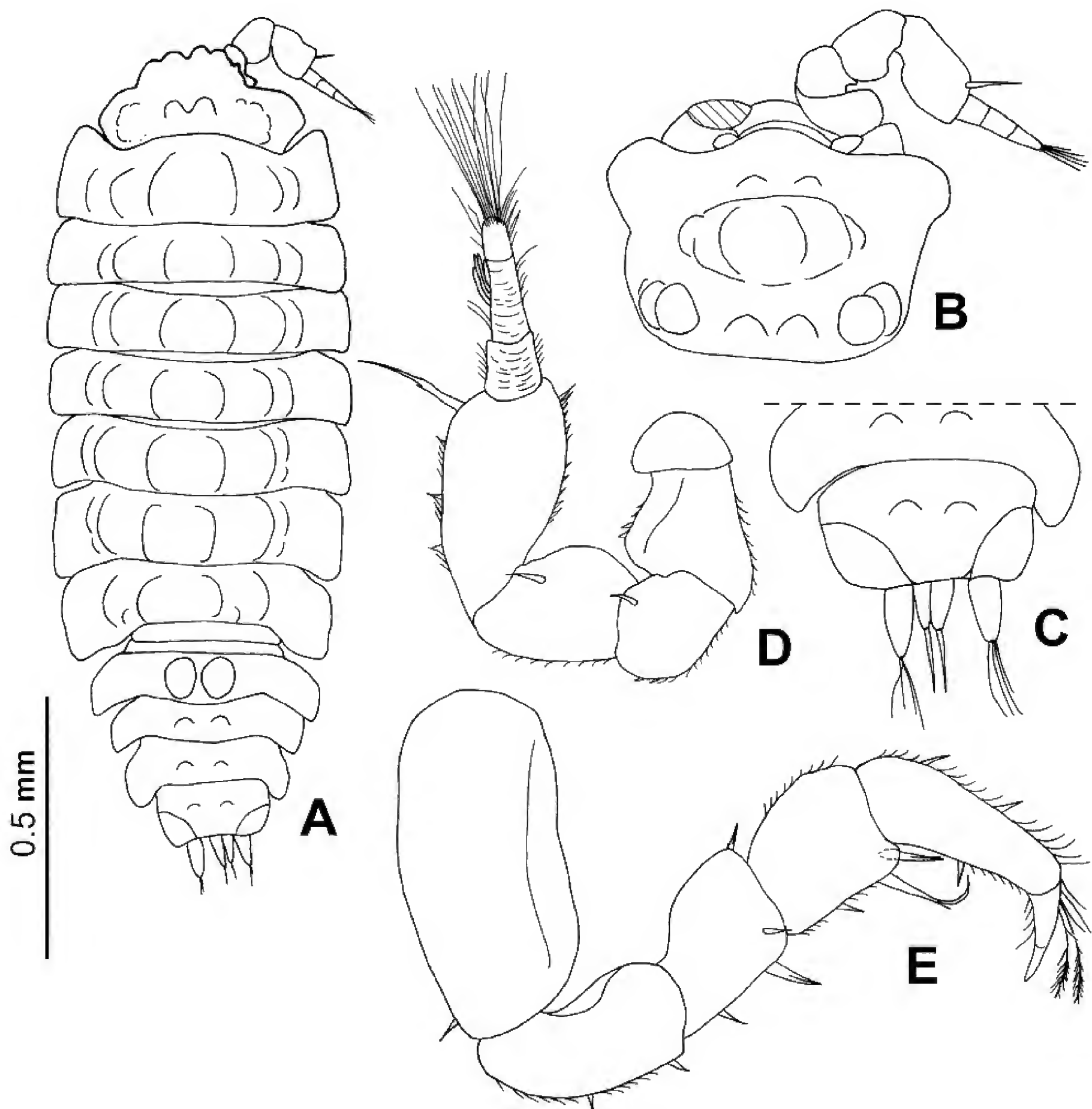
#### Holotype

PORTUGAL: ♂, Gruta do Almonda (= Gruta do Olho da Fonte), Estremenho Massif, 24 Aug. 2013 (MZUF).



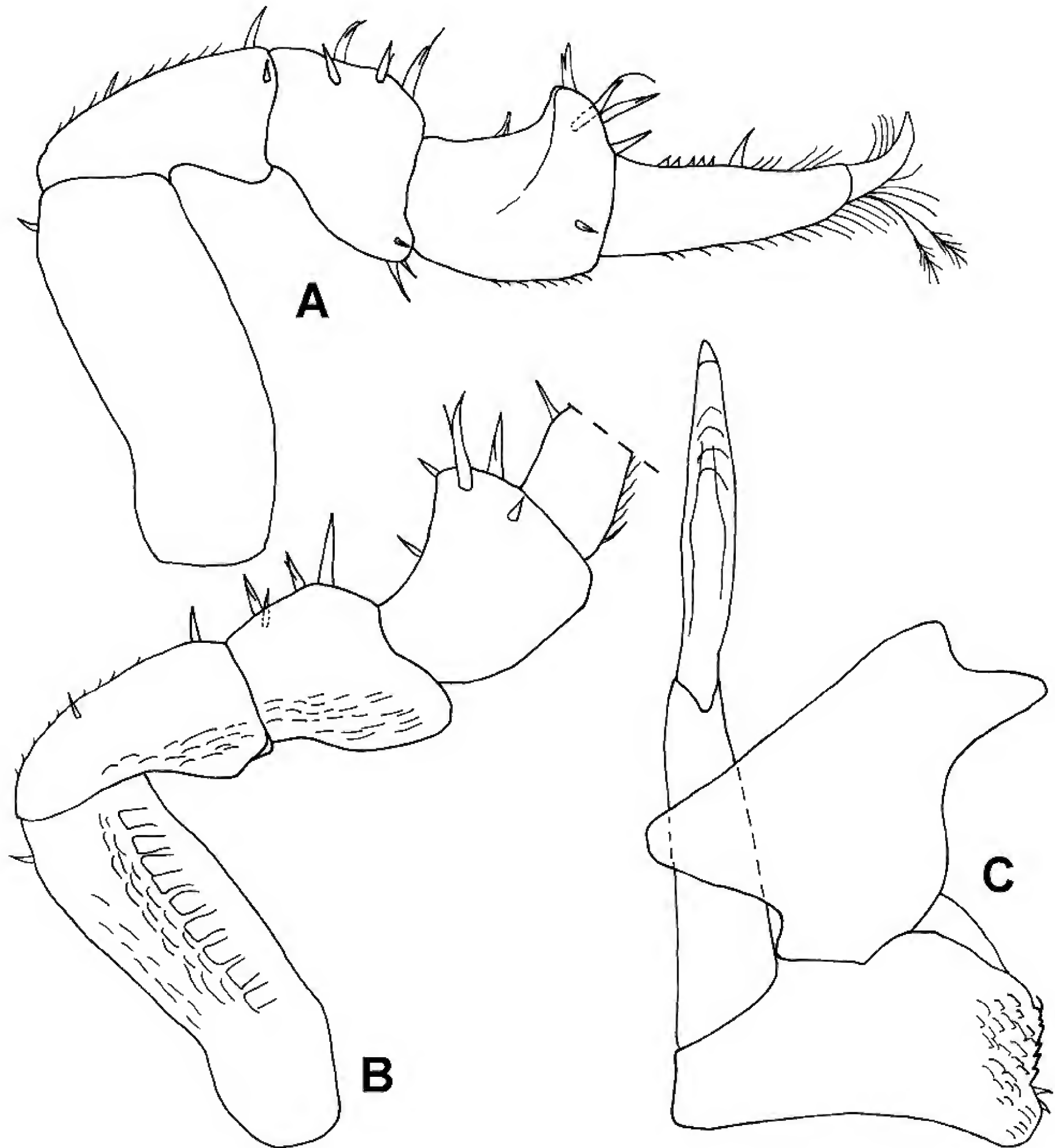
**Description**

Size: 1.5 × 0.6 mm. Body colourless, ovoidal, outline not interrupted between pereon and pleon; pereon tergites very convex, with epimera obliquely directed outwards (Fig. 21A). Dorsum bearing ribs and tubercles (Fig. 21A): cephalon with large central tubercle with 3 + 3 rounded tips, and 3 + 3 tubercles near rear margin, the two external ones fused at base; pereonites 2–6 with 3 + 3 longitudinal ribs as long as tergites; pereonite 7 with 2 + 2 ribs and small tubercle per side between two ribs; pleonite 3 with 2 large paramedian tubercles; pleonites 4 and 5 and telson with 2 small paramedian tubercles. Cephalon (Fig. 21B) with short, quadrangular frontal lateral lobes, directed outwards and not protruding compared with median lobe. Eyes absent. Pereonites with rounded posterior corners; epimera 4–7 slightly pointing backwards



**Fig. 21.** *Moserius inexpectatus* Reboleira & Taiti sp. nov. from Gruta do Almonda, Estremenho, paratype, ♂. **A.** Specimen in dorsal view. **B.** Cephalon in dorsal view. **C.** Pleonite 5, telson and uropod. **D.** Antenna. **E.** Pereopod 1.

(Fig. 21A). Pleonites 3–5 (Fig. 21A, C) with large epimera directed backwards. Telson (Fig. 21C) about twice as wide as long, with distal part trapezoidal, with concave sides and truncate apex. Antenna (Fig. 21D) with thickset articles of peduncle; flagellum with three articles, with 3–4 long aesthetascs on second article. Uropod (Fig. 21C) with flattened protopod; exopod slightly longer than endopod, with tuft of four apical setae; endopod with single apical seta. Pereopod 1 (Fig. 21E) with no particular modifications. Pereopod 7 (Fig. 22A–B) ischium with slightly convex sternal margin, carpus with large distal lobe on sternal margin. Pleopod 1 (Fig. 22C) exopod quadrangular, with truncate and sinuous distal point, sinuous outer margin and straight medial margin.



**Fig. 22.** *Moserius inexpectatus* Reboleira & Taiti sp. nov. from Gruta do Almonda, Estremenho, Estremoz-Cano Massif, paratype, ♂. **A.** Pereopod 7, caudal view. **B.** Pereopod 7, rostral view. **C.** Pleopod 1.

**Remarks**

This new blind species belongs to the subfamily Haplophthalminae and is included in *Moserius* since it shows the tergal ornamentation typical of the genus, i.e., 3+3 ribs on the pereonites and two large tubercles on pleonite 3. The genus *Moserius* was previously known only for two species: *M. percoi* Strouhal, 1940, originally described from the cave Belinca Jama, Slovenia, and later recorded from Ligurian and Tuscan caves (Strouhal 1940; Brian 1963; Taiti & Ferrara 1995), and *M. elbanus* Taiti & Ferrara, 1995, from a small cave on Elba Island, Tuscany, Italy. The new species is readily distinguished from the other two members of the genus by the peculiar shape of the male pleopod 1 exopod, with a truncate and sinuous, rather than triangular, distal point. The location of *M. inexpectatus* (Portugal) is very far from those of the other two species (northern Italy and Slovenia), but it is quite probable that other species are present in the countries encompassing the northwestern Mediterranean.

**Ecological notes**

This species occurs in the Gruta do Almonda, the largest Portuguese cave, with at least 10 km of mapped subterranean galleries. It shares habitat with other troglobiotic species, namely the spider *Nesticus lusitanicus* Fage, 1931, the woodlouse *Trichoniscoides meridionalis*, and the beetle *Trechus lunai* Reboleira & Serrano, 2009 (Reboleira *et al.* 2009).

Family Styloniscidae Vandel, 1952

Genus *Cordioniscus* Gräve, 1914

*Cordioniscus lusitanicus* Reboleira & Taiti sp. nov.

[urn:lsid:zoobank.org:act:B1F2D756-D90F-43BF-9F42-4F8EAE6C79F0](https://zoobank.org/urn:lsid:zoobank.org:act:B1F2D756-D90F-43BF-9F42-4F8EAE6C79F0)

Figs 23A–G, 24A–E, 25A–E

**Diagnosis**

A blind species of *Cordioniscus* characterised by a colourless body, the male pereopod 7 ischium having a rounded hyaline basal lobe, the triangular male pleopod 1 exopod, as long as the endopod, and the complex apical part of the male pleopod 2 endopod.

**Etymology**

From Latin *lusitanicus* = Portuguese. The name refers to the country where the specimens were collected.

**Material examined****Holotype**

PORTUGAL: ♂, Algar de Santo António, Estremoz-Cano Massif, 30 Mar. 2009 (MZUF).

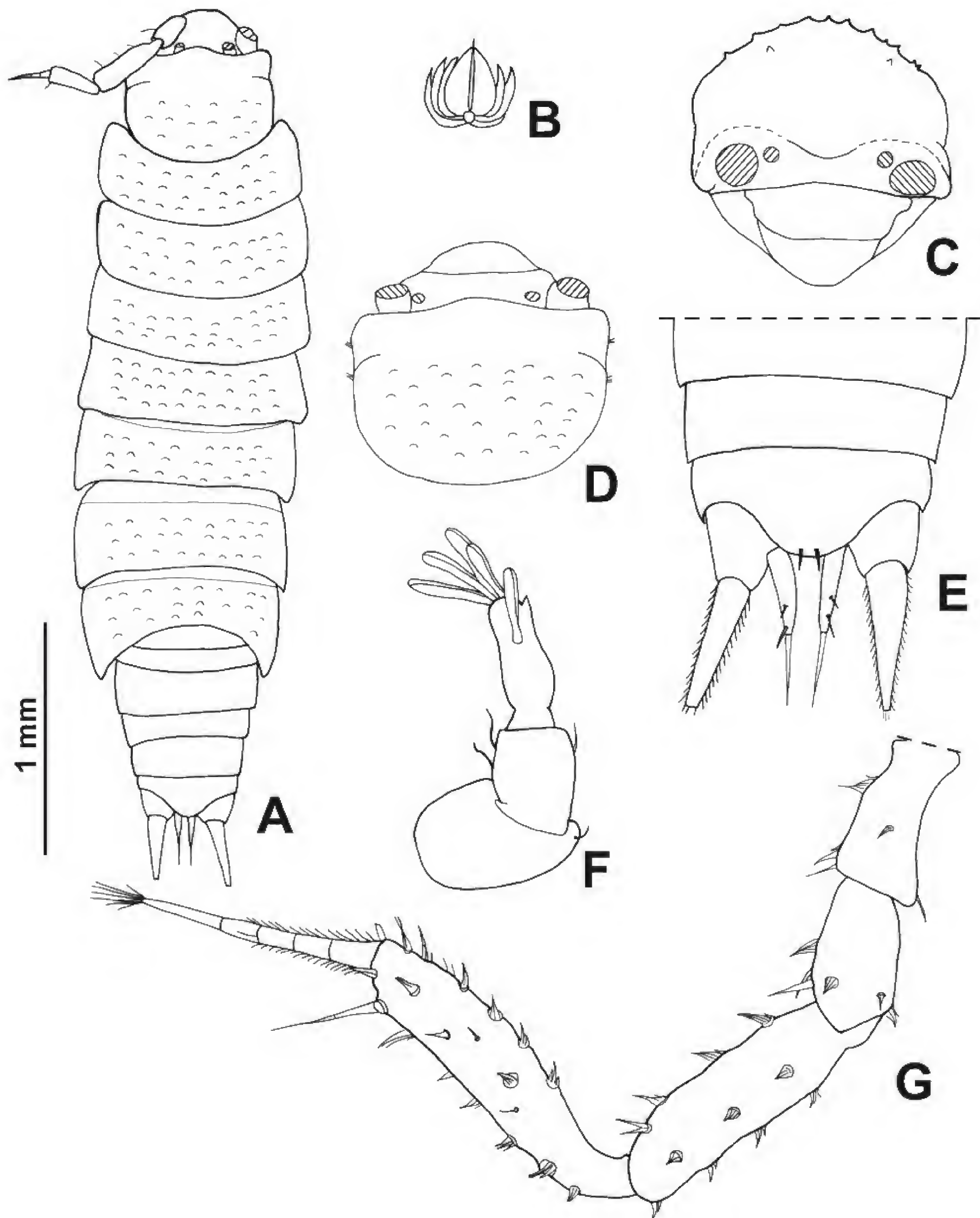
**Paratypes**

PORTUGAL: 1 ♂, 7 ♀♀, same data as holotype, 30 Mar. 2009 (MZUF); 2 ♂♂, 1 ♀, Gruta de Ibne Ammar, Algarve Massif, 23 May 2009 (MZUF); 3 ♂♂, same locality and date (SR); 3 ♀♀, Algarão do Remexido, Algarve Massif, 5 Sep. 2009 (SR); 1 ♂, same locality, 30 Jan. 2009 (MZUF); 2 ♀♀, same locality, 29 Dec. 2009 (SR); 1 ♂ juv., 2 ♀♀, Gruta da Senhora, Algarve Massif, 3 Jul. 2011 (ZMUC); 1 ♂, same locality, 18 May 2013 (SR).

**Description**

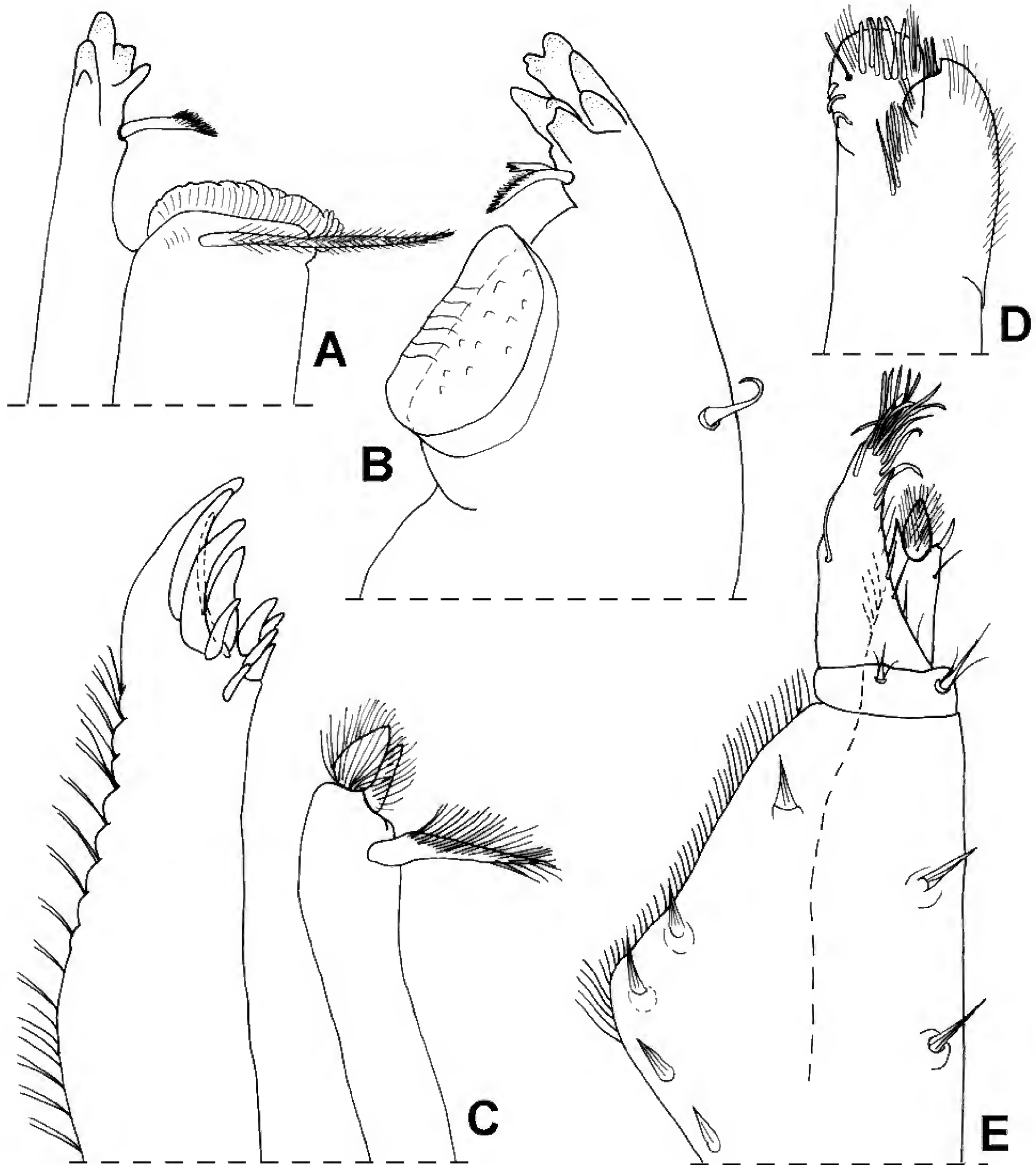
Maximum size: ♂ 5.0 × 1.0 mm; ♀ 3.0 × 0.8 mm. Body colourless and elongated (Fig. 23A). Dorsum of cephalon and pereon finely granulated and equipped with triangular scale-setae (Fig. 23B); pleon and telson smooth. Cephalon (Fig. 23C–D) with short, rounded frontal lateral lobes. Eyes absent. Pereonites

1–3 with rounded posterior corners; pereonites 4–7 with epimera pointing backwards (Fig. 23A). Pleon (Fig. 23A, E) narrower than pereon; pleonites 3–5 with epimera reduced and no posterior points.



**Fig. 23.** *Cordioniscus lusitanicus* Reboleira & Taiti sp. nov. from Algar de Santo António, Estremoz-Cano. — Paratype, ♀. **A.** Adult specimen in dorsal view. — Paratype, ♂. **B.** Dorsal scale-seta. **C.** Cephalon in frontal view. **D.** Cephalon in dorsal view. **E.** Pleonites 4, 5, telson and uropods. **F.** Antennula. **G.** Antenna.

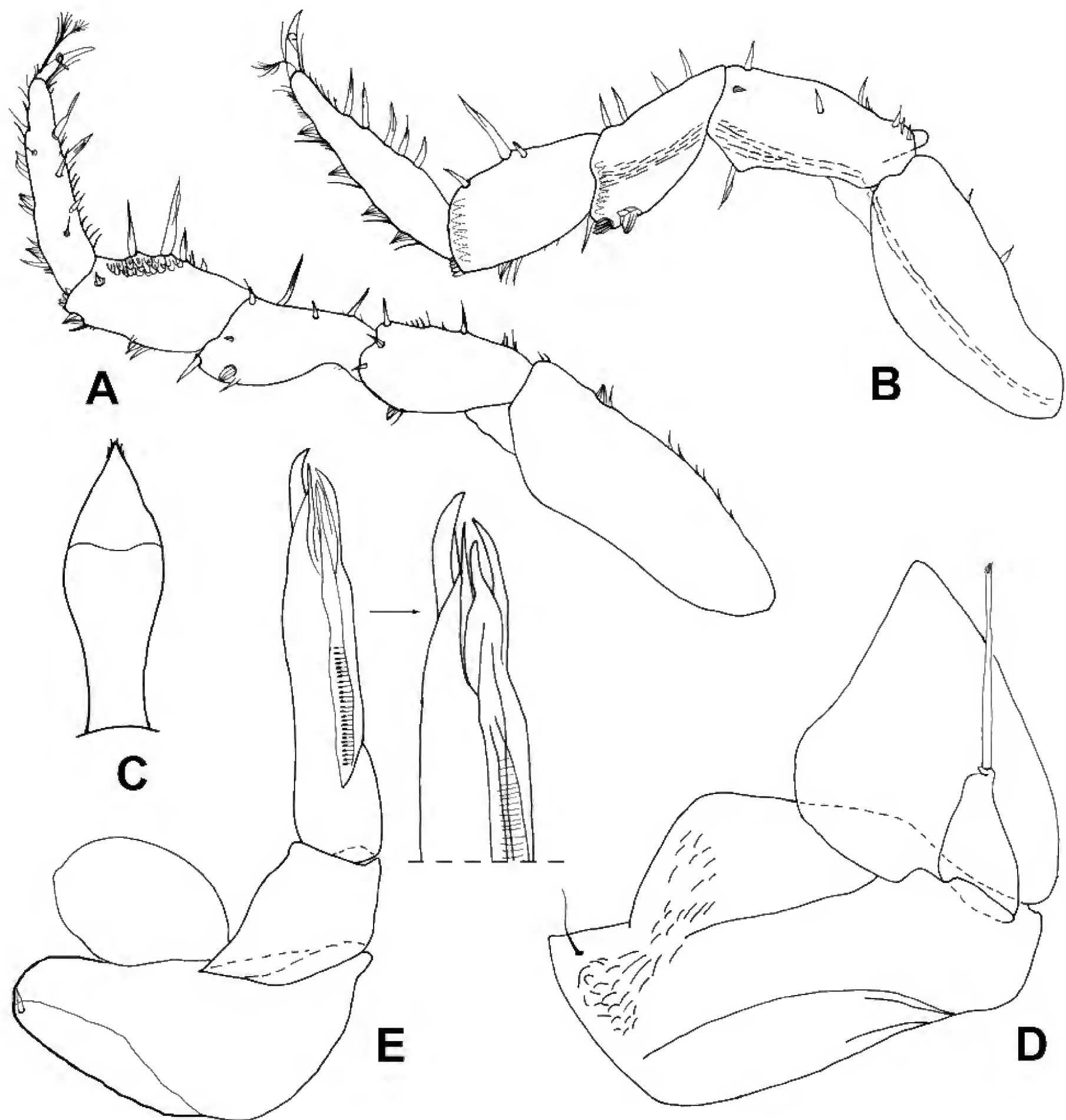
Telson (Fig. 23E) about twice as wide as long, distal part with concave sides and broadly rounded apex. Antennula (Fig. 23F) with third article longer than first and second articles, with small triangular posterior point, and with one subapical and four apical, long aesthetascs. Antenna (Fig. 23G) with articles of peduncle bearing scale-setae; fifth article distinctly longer than flagellum; flagellum with four articles, with very long apical organ. Right mandible (Fig. 24A) with one penicil between lacinia mobilis and molar process, which bears long penicil; left mandible (Fig. 24A) with two penicils. Maxillula (Fig. 24C) inner branch bearing two thickset penicils at apex and long subapical penicil; outer branch



**Fig. 24.** *Cordioniscus lusitanicus* Reboleira & Taiti sp. nov. from Algar de Santo António, Estremoz-Cano, paratype, ♀. **A.** Right mandible. **B.** Left mandible. **C.** Maxillula. **D.** Maxilla. **E.** Maxilliped.

with 10 teeth and thin, setose stem among outer group of teeth. Maxilla (Fig. 24D) apically bilobed and setose, with outer and inner lobes subequal; inner lobe with several long, stout setae along margin. Maxilliped (Fig. 24E) basis enlarged in middle; endite triangular, with stout triangular penicil at apex; palp distally rounded, with long setae at apex, and basal article with two short compound setae. Uropod (Fig. 23E) with exopod distinctly longer than endopod, endopod inserted proximally to exopod.

MALE. Pereopod 1 (Fig. 25A) with no particular modifications. Pereopod 7 (Fig. 25B) ischium with slightly convex sternal margin and bearing rounded hyaline lobe at base. Genital papilla (Fig. 25C) lanceolate with pointed apex, shorter than pleopod 1. Pleopod 1 (Fig. 25D) exopod triangular, as long as endopod; endopod with short triangular basal article and flagelliform distal article. Pleopod 2 (Fig. 25E)



**Fig. 25.** *Cordioniscus lusitanicus* Reboleira & Taiti sp. nov. from Algar de Santo António, Estremoz-Cano, paratype, ♂. **A.** Pereopod 1. **B.** Pereopod 7. **C.** Genital papilla. **D.** Pleopod 1. **E.** Pleopod 2.

exopod small, ovoidal; endopod biarticulated, distal article thickset, about three times as long as basal article, with parallel sides and complex apical part.

### Remarks

At present the genus *Cordioniscus* includes with certainty 14 species (Andreev 2002; Schmalfuss 2003), mainly distributed in caves of Mediterranean countries. For a definition of the genus see Schmalfuss & Erhard (1998). Species of *Cordioniscus* are mainly distinguishable by the shape of the male pleopod 2 endopod. In the Iberian Peninsula, only *Cordioniscus stebbingi* (Patience, 1907) was previously known from some caves in Valencia and Castellón provinces, Spain (Vandel 1952b). The new species differs from *C. stebbingi* in the lower number of aesthetascs on the antennula (5 vs 8), the presence of a hyaline lobe on the male pereopod 7 ischium, and the thickset and complex, rather than tapering, distal part of the male pleopod 2 endopod. In the presence of a lobe at the base of the male pereopod 7 ischium, *C. lusitanus* Reboleira & Taiti sp. nov. is similar to *C. bulgaricus* Andreev, 1986 from Bulgaria and *C. andreevi* Schmalfuss & Erhard, 1998, *C. beroni* Vandel, 1968, *C. graecus* Vandel, 1959 and *C. kithnosi* Andreev, 1986 from Greece (Vandel 1959, 1968; Andreev 1986a, 1986b; Schmalfuss & Erhard 1998). It differs from all these species in the different structure of the male pleopod 2 endopod.

### Ecological notes

This species was collected in two isolated karst areas, Alentejo and Algarve. These two areas are more than 200 km apart and are separated by the extended dry, flat areas of Alentejo Province. In the Algarve Massif this species is frequent in caves. In the northern locality, Algar de Santo António in Alentejo, the specimens were collected in deep layers of soil at the bottom of the first pit (–20 m), where it cohabits with the troglotrophic millipede *Sireuma nobile* Reboleira & Enghoff, 2014 (Reboleira & Enghoff 2014b).

Family Philosciidae Kinahan, 1857

Genus *Anaphiloscia* Racovitza, 1907

*Anaphiloscia sicula* Arcangeli, 1934

*Anaphiloscia sicula* Arcangeli, 1934: 152, figs 1–19.

*Anaphiloscia sicula* – Vandel 1946: 202, figs 50–59.

### Records

Algueirão, Pechão; Algarão Menor do Paulino, Loulé, Algarve Province (Vandel 1946).

### Distribution

Portugal, Sicily, Ustica Island, Pantelleria Island and Malta.

### Remarks

According to Schmalfuss (2003), this blind and depigmented species might be a junior synonym of *Anaphiloscia simoni* Racovitza, 1907, described on the basis of a female specimen from a cave on Mallorca, Balearic Islands (Racovitza 1907; Arcangeli 1934) and later recorded from western Spain, Morocco, Algeria and Libya (Cyrenaica). Vandel (1972) seems to have considered the two species as synonymous, without formally discussing the issue (Schmalfuss 2003). Since no illustrations of the male characters of *A. simoni* exist, it is impossible to clarify this taxonomic problem without a re-examination of the type material. No specimens of this genus have been collected during our investigations.

### Ecological notes

Epigeal species.

Genus *Ctenoscia* Verhoeff, 1928

*Ctenoscia minima* (Dollfus, 1892)

*Philoscia minima* Dollfus, 1892: 187, 3 figs.

*Ctenoscia minima* – Vandel 1946: 196, figs 42–49.

#### Material examined

PORTUGAL: 1 ♀, Gruta da Assafora, Sintra, 4 Apr. 2011 (SR).

#### Previous records

Algarão da Ribeira de Alte, Paderne; Algarão do Barrocal do Esguicho, Loulé, Algarve Province (Vandel 1946).

#### Distribution

Portugal, Spain (including Canary and Balearic Islands), Corsica, Sardinia, northwestern Italy, Sicily and surrounding islands, Malta, Tunisia and Morocco (Rif).

#### Remarks

This epigean species was recently discussed and fully illustrated by Taiti & Rossano (2015), who considered it to be a senior synonym of *Ctenoscia dorsalis* (Verhoeff, 1928).

#### Ecological notes

Epigean species.

Family Platyarthridae Verhoeff, 1949

Genus *Trichorhina* Budde-Lund, 1908

*Trichorhina anophthalma* Arcangeli, 1935  
Figs 26A–G, 27A–C

*Trichorhina anophthalma* Arcangeli, 1935b: 23, figs 19–24.

*Trichorhina anophthalma* – Vandel 1946: 216, figs 62–63. — Schmölzer 1965: 281, fig. 1104; 1971: 28, 89, 146. — Schmalfuss 2003: 315.

#### Material examined

PORTUGAL: 1 ♂, 1 ♀, Algar de Santo António, Estremoz-Cano Massif, 30 Dec. 2009 (MZUF); 9 ♀♀, 4 ♀♀, 1 juv., same locality, 30 Mar. 2009 (MZUF); 5 ♂♂, 3 ♀♀, same locality, 22 May 2009 (SR); 4 ♂♂, 4 ♀♀, same locality, 4 Sep. 2009 (ZMUC); 1 ♂, Gruta do Vale Telheiro, Algarve Massif, 30 Jun. 2011 (MZUF); 2 ♀♀, Gruta da Senhora, Algarve Massif, 3 Jul. 2011 (SR).

#### Previous records

Serpa, Alentejo (Arcangeli 1935b). Palmela, Serra da Arrábida, Setúbal (Vandel 1946).

#### Distribution

Known with certainty from southern Portugal and southern Spain (Schmölzer 1971).

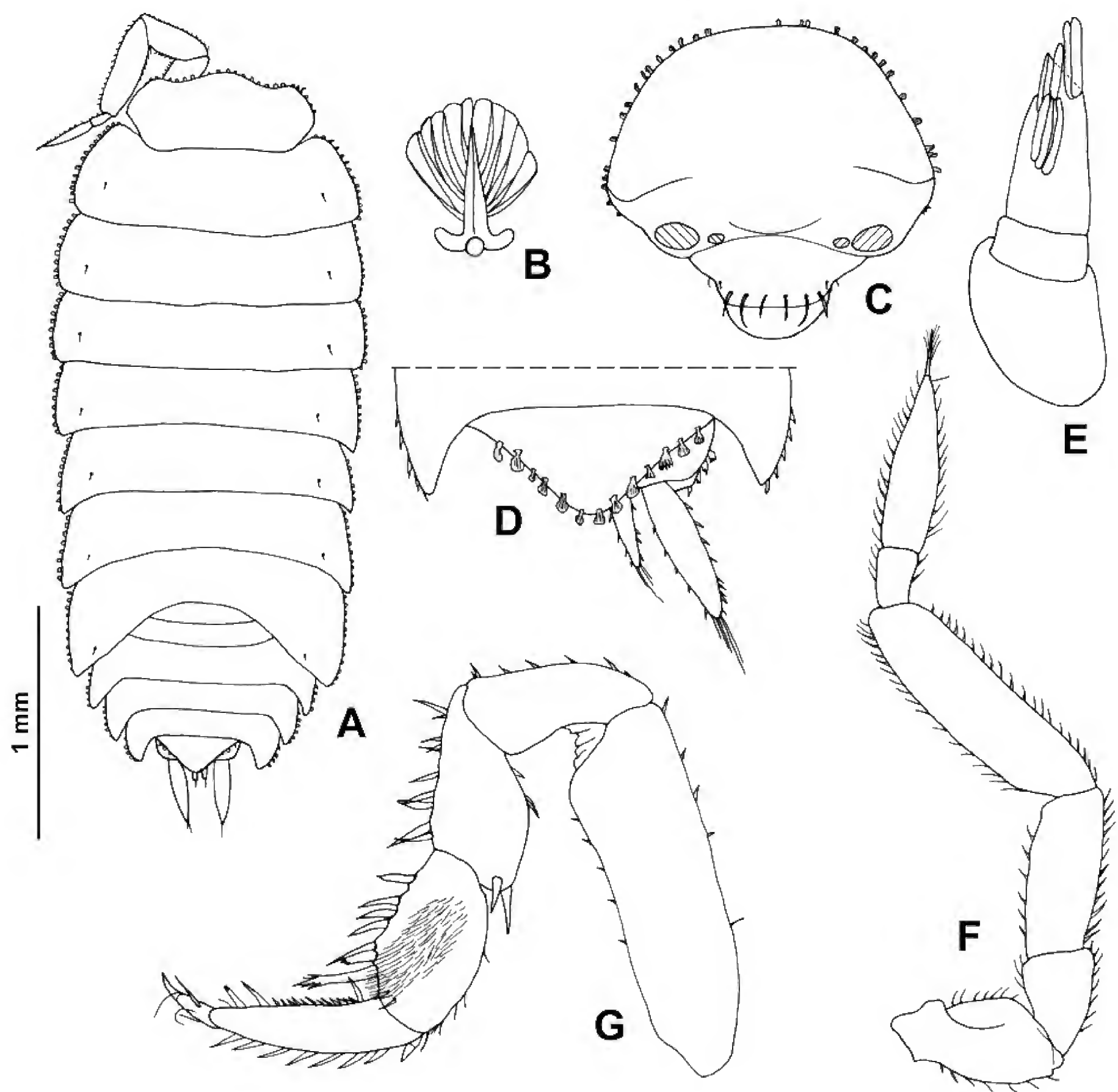


**Remarks**

*Trichorhina anophthalma* is fully illustrated here (Figs 26–27) to facilitate its identification. Hoesé (1984) recorded this species from the Canary Islands (Fuerteventura and Tenerife) and considered *T. hoestlandti* Vandel, 1960 from Madeira (Vandel 1960b) to be a junior synonym of that species. Contrary to this, Schmalzfuss (2003) regarded both species as valid. A re-examination of specimens of *Trichorhina hoestlandti* from Madeira is necessary in order to define the taxonomic status of this species. The specimens of *Trichorhina* from the Canary Islands recorded by Hoesé (1984) also need to be examined for a correct identification.

**Ecological notes**

This species is probably endogean and troglophile rather than a true troglobiont.



**Fig. 26.** *Trichorhina anophthalma* Ancangeli, 1935 from Algar de Santo António, Estremoz-Cano, ♂. A. Adult specimen in dorsal view. B. Scale-seta. C. Cephalon in frontal view. D. Pleonite 5, telson and right uropod. E. Antennula. F. Antenna. G. Pereopod 1.

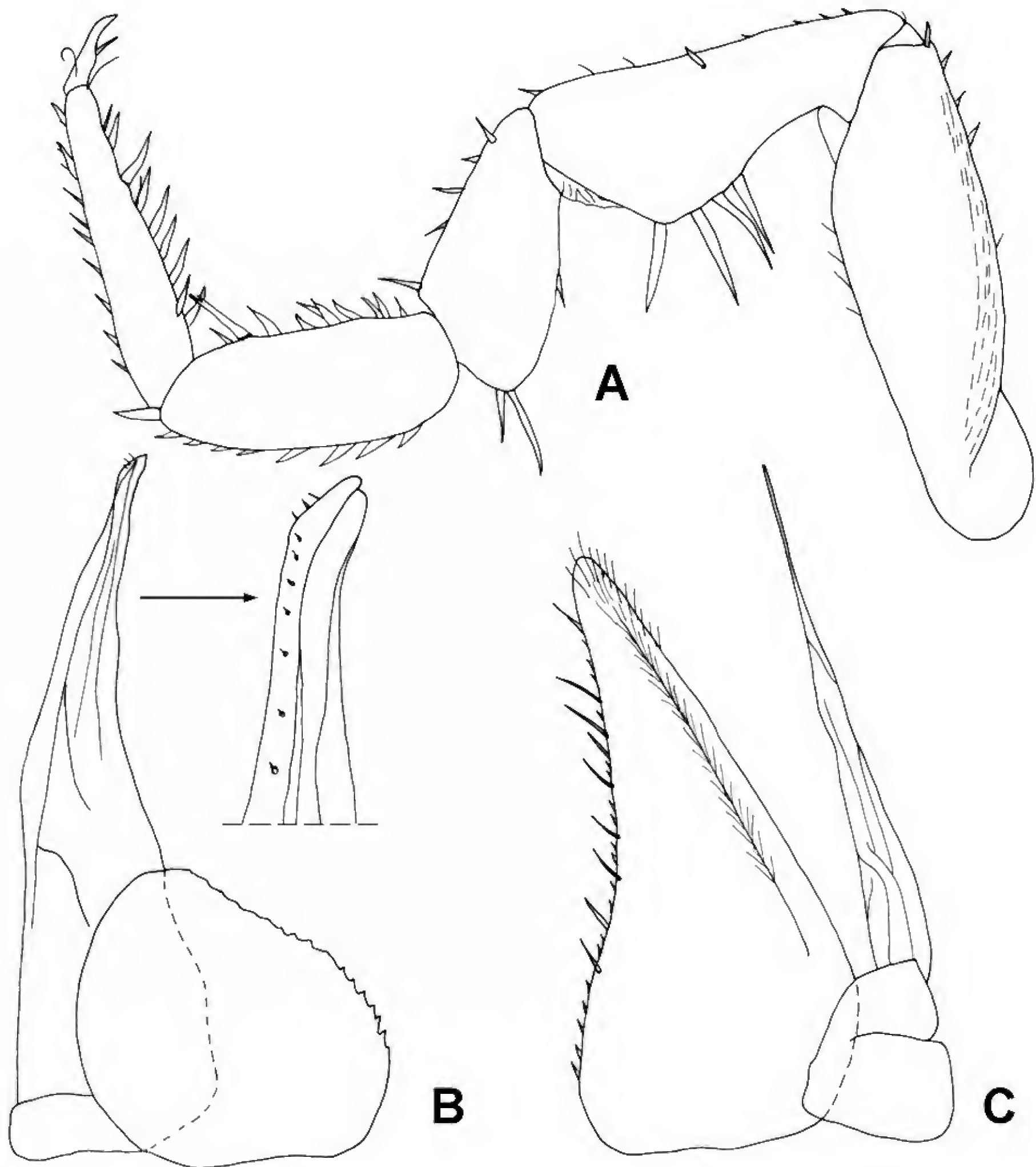
Family Porcellionidae Brandt, 1831

Genus *Porcellionides* Miers, 1877

*Porcellionides pruinosus* (Brandt, 1833)

*Porcellio pruinosus* Brandt, 1833: 481.

*Metoponorthus* (*Metoponorthus*) *pruinosus* – Vandel 1946: 272, figs 87–90.



**Fig. 27.** *Trichorhina anophthalma* Ancangeli, 1935 from Algar de Santo António, Estremoz-Cano, ♂. A. Pereopod 7. B. Pleopod 1. C. Pleopod 2.

**Material examined**

PORTUGAL: 1 ♀, Algar de Santo António, Estremoz-Cano Massif, 22 May 2009 (SR).

**Previous records**

Grutas dos Moinhos da Rocha, Tavira, Faro (Vandel 1946).

**Distribution**

Cosmopolitan species of Mediterranean origin.

**Ecological notes**

Epigeal species, occasionally found at cave entrances.

*Porcellionides sexfasciatus* (Budde-Lund, 1885)

*Metoponorthus sexfasciatus* Budde-Lund, 1885: 167.

*Metoponorthus (Polytretus) sexfasciatus lusitanus* – Vandel 1946: 269, figs 80b–d.

**Records**

Gruta do Algar, Mexilhoeirinha, Lagoa; Algarão, Pechão, Algarve Province (Vandel 1946).

**Distribution**

Western Mediterranean region, Atlantic coast of Europe and northern Africa, including Atlantic islands. It has also been introduced to many other parts of the world.

**Ecological notes**

Epigeal species, troglone.

*Porcellionides cingendus* (Kinahan, 1857)

*Porcellio cingendus* Kinahan, 1857: 279, pl. 19, figs 1–2, 4, 6, 8–9.

*Metoponorthus (Lusitanoniscus) cingendus* – Vandel 1946: 274, figs 91–97.

**Records**

Gruta Baixa do Cabeço dos Mosqueteiros, Aljubarrota; Cova dos Mouros de Vale Ribeiro, Lagoa do Cão, Alcobaça (Vandel 1946).

**Distribution**

Southern British Isles, Atlantic coasts of France, Portugal and Spain.

**Ecological notes**

Epigeal species, troglone.

Genus *Porcellio* Latreille, 1804

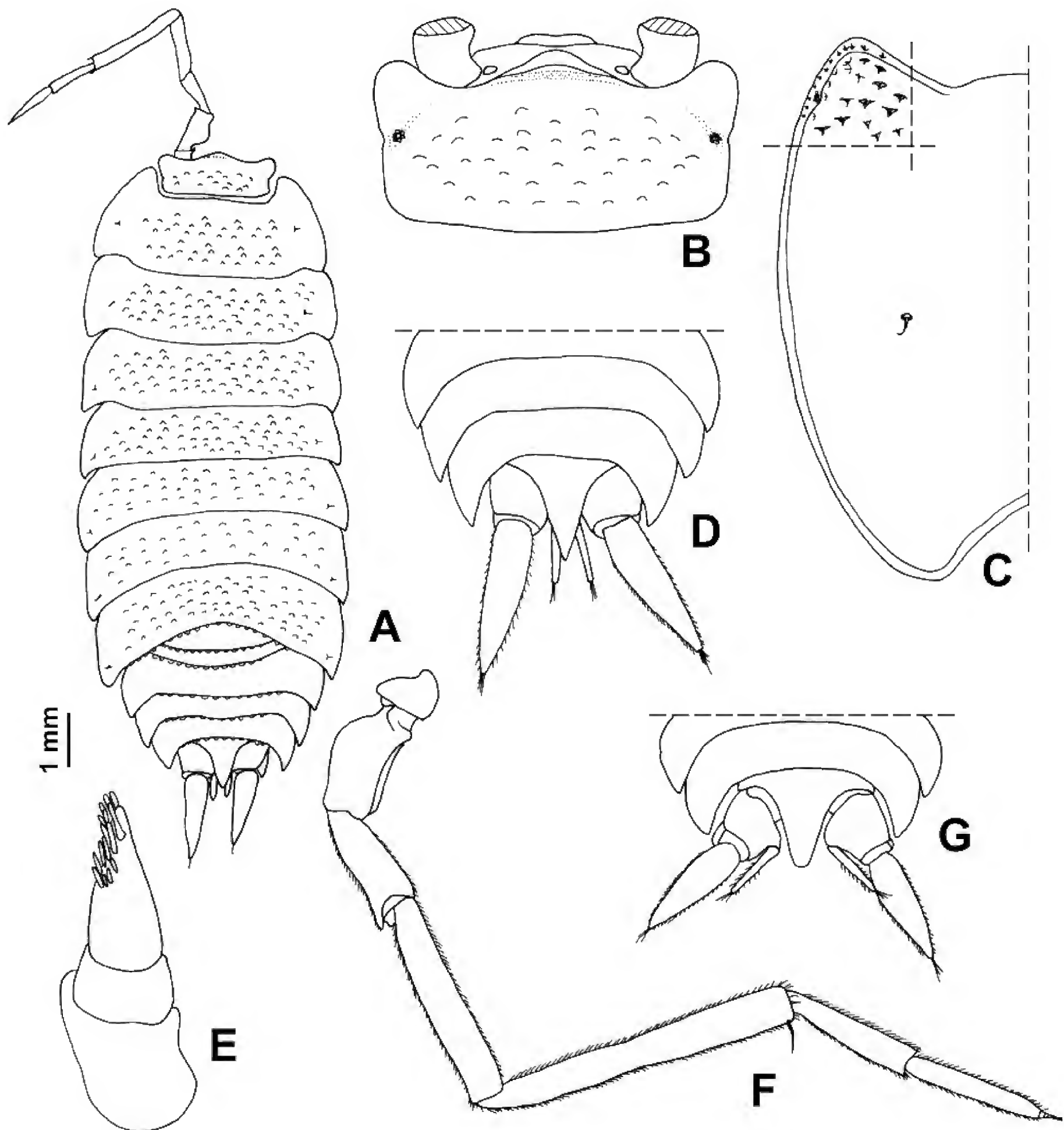
*Porcellio cavernicolus* Vandel, 1946  
Figs 28A–G, 29A–F

*Porcellio cavernicolus* Vandel, 1946: 330, figs 137–143.

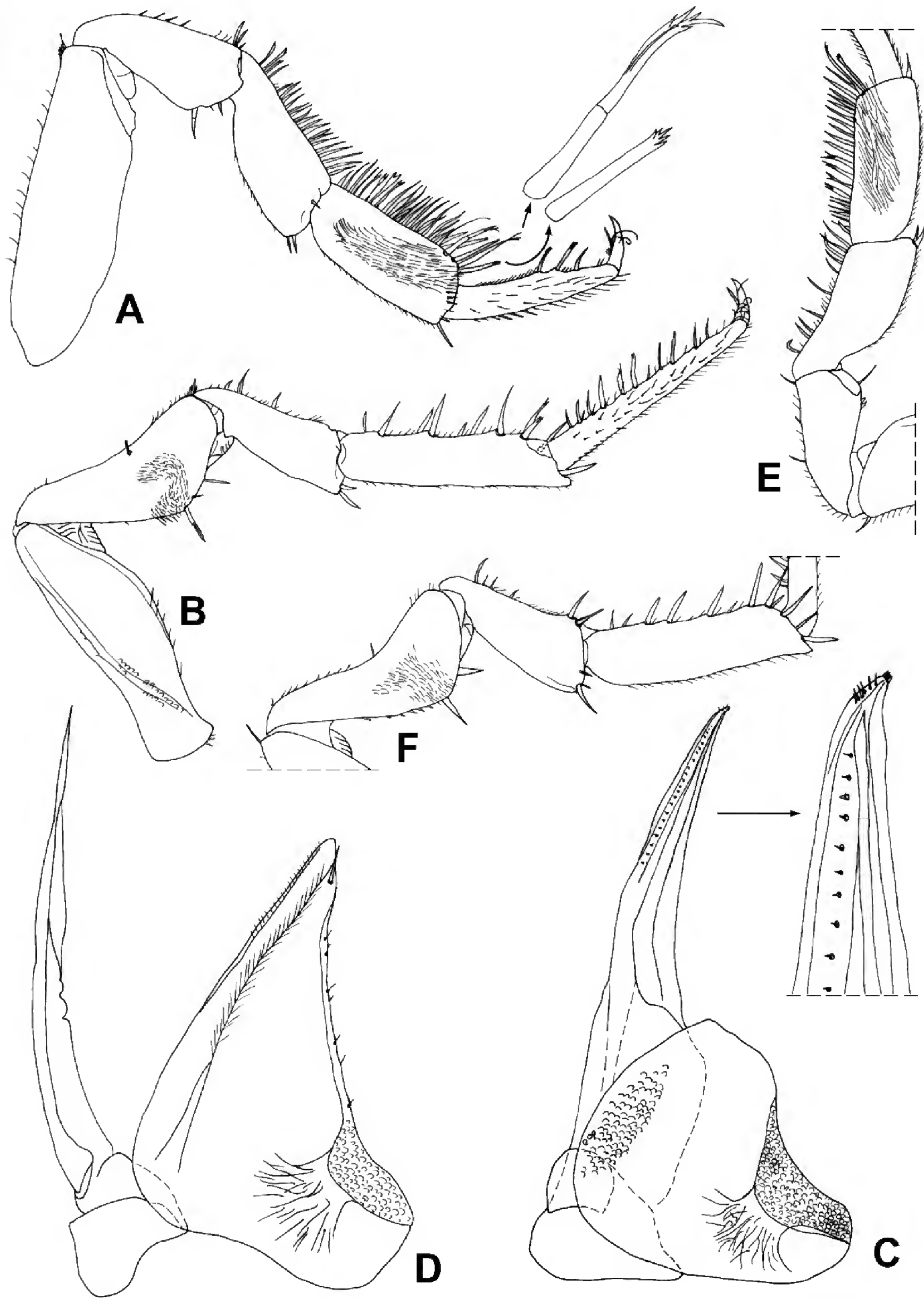
*Porcellio cavernicolus* – Schmölzer 1965: 208, figs 745–746; 1971: 37, 95, 149. — Schmalzfuss 2003: 220. — Reboleira *et al.* 2011a: 27, fig. 3, table 1.

**Material examined**

PORTUGAL: 8 ♂♂, 5 ♀♀, Gruta d'el Rey, Cantanhede-Outil Massif, 19 May 2009 (MZUF); 4 ♂♂, 5 ♀♀, 6 juvs, same locality, 8 Oct. 2009 (SR); 5 ♂♂, 4 ♀♀, Gruta da Senhora da Estrela, Sicó Massif, 11 Jun. 2009 (MZUF); 3 ♂♂, 2 ♀♀, same locality, 20 Nov. 2009 (SR); 1 ♂, 1 ♀, same locality, 29 Aug. 2009 (ZMUC); 1 ♂, Gruta do Soprador do Carvalho, Sicó Massif, 30 Jul. 2007 (MZUF); 2 ♂♂, same locality, 17 Jan. 2009 (SR); 1 ♂, 2 ♀♀, same locality, 30 Jul. 2009 (ZMUC); 1 juv., same locality, 21 Mar. 2009 (SR); many ♂♂ and ♀♀, Gruta do Algarinho, Sicó Massif, 21 Mar. 2012 (MZUF); many ♂♂ and ♀♀, same locality, 10 Jun. 2012 (SR); 1 ♀, 2 juvs, Gruta da Cerâmica, Sicó Massif, 28 Nov.



**Fig. 28.** *Porcellio cavernicolus* Vandel, 1946. — ♂ from Gruta da Cerâmica, Sicó. **A.** Adult specimen in dorsal view. **B.** Cephalon in dorsal view. **C.** Epimeron of pereonite 1. **D.** Pleonites 3–5, telson and uropods. **E.** Antennula. **F.** Antenna. — ♂ from Gruta d'el Rey. **G.** Pleonite 4, 5, telson and uropods.



**Fig. 29.** *Porcellio cavernicolus* Vandel, 1946. — ♂ from Gruta da Cerâmica, Sicó. **A.** Pereopod 1. **B.** Pereopod 7. **C.** Pleopod 1. **D.** Pleopod 2. — ♂ from Gruta d'el Rey, Cantanhede-Outil Massif. **E.** Pereopod 1. **F.** Pereopod 7.

2009 (SR); many ♂♂ and ♀♀, same locality, 28 Nov. 2009 (MZUF); many ♂♂ and ♀♀, same locality, 21 Mar. 2010 (SR); 1 ♂, same locality, 29 Aug. 2009 (SR); many ♂♂ and ♀♀, same locality, 27 Dec. 2010 (ZMUC); 1 ♀, 3 juvs, Gruta Abrigo Tomar I, Sicó Massif, 26 Sep. 2011 (SR).

#### **Previous records**

Algar da Lapa, Ansião; Gruta dos Alqueves, São Martinho do Bispo, Coimbra (Vandel 1946). 3 ♂♂, 2 ♀♀, Gruta Maior da Furjaca, Pampilhosa, Coimbra, 26 Feb. 1987, A. Serra leg. (Cruz 1990).

#### **Distribution**

Species endemic to caves in central Portugal, from Cantanhede-Outil to the southernmost border of the Sicó Massif, but so far absent from the Estremenho karst massif.

#### **Remarks**

This troglobiotic species is fully illustrated here (Figs 28–29) to facilitate its recognition. The finding of this species in Gruta d’el Rey, Cantanhede-Outil Massif, another isolated karst area far from the Sicó localities from where it was described, considerably enlarges the distribution of this species. Populations from the two distinct karst areas show some small differences which, however, do not seem to justify a split of the species. The specimens from Gruta d’el Rey have the apex of the telson more rounded (compare Fig. 28D with 28G), the male pereopod 1 has less numerous setae on the sternal margin of the merus (compare Fig. 29A with 29E), and the male pereopod 7 has a more concave sternal margin of the ischium (compare Fig. 29B with 29F) than specimens from the type locality.

#### **Ecological notes**

This species inhabits the most superficial parts of the caves. It can frequently be found on roots hanging from the ceiling, from which specimens can easily be distinguished by their whitish coloration.

#### *Porcellio dilatatus dilatatus* Brandt, 1831

*Porcellio dilatatus* Brandt in Brandt & Ratzeburg, 1831: 78, pl. 12, fig. 6c–d.

*Porcellio (Porcellio) dilatatus* – Arcangeli 1935b: 12.

*Porcellio dilatatus* – Vandel 1946: 316, fig. 135.

#### **Material examined**

PORTUGAL: many ♂♂ and ♀♀, Gruta d’el Rey, Cantanhede-Outil Massif, 8 Oct. 2009 (MZUF); many ♂♂ and ♀♀, Gruta dos Moinhos Velhos, Estremenho Massif, 26 Dec. 2006 (ZMUC); 1 ♂, 1 ♀, Gruta dos Bolhos, Cesaredas Plateau, 18 Sep. 2009 (SR); 1 ♀, Gruta de Salir, Caldas da Rainha typhonic valley, 23 May 2013 (SR); many ♂♂ and ♀♀, Lapa da Furada, Arrábida Massif, 14 Jun. 2009 (SR).

#### **Previous records**

Beja (Arcangeli 1935b). Gruta de Ferreiros, Santo Adrião, Miranda do Douro, Bragança; Ermesinde, Valongo, Porto; Gruta de Sabadal, Portunhos, Cantanhede, Coimbra; Gruta dos Alqueves, S. Martinho do Bispo, Coimbra; Gruta de Legação, Rabaçal, Penela, Coimbra; Algar N. 1 das Corujeiras, Pombal, Leiria; Algar da Lapa, Anciã, Leiria; 1ª Cova da Moura da Ribeira do Sirol, Leiria; Loca dos Vales, Cortes, Leiria; Gruta Alta do Cabeço dos Mosqueiros, Aljubarrota, Leiria; Gruta Baixa do Cabeço dos Mosqueiros, Aljubarrota, Leiria; Algar de João Ramos, Turquel, Leiria; Cova da Moura do Cabeço de Turquel, Alcobaça, Leiria; Algar n° 2 de Pinheiro, Benedita, Leiria; Casa da Moura, Cesareda, Peniche, Leiria; Gruta do Almonda, Torres Novas, Santarém; Gruta da Senhora da Luz, Rio Maior, Santarém; Gruta das Alcobertas, Rio Maior, Santarém; Algarve da Terra da Rôlha, Cadaval, Lisboa; Gruta N. do Furadoro, Cadaval, Lisboa; Cova da Moura, Cercal, Cadaval, Lisboa; Lapa dos Morcegos, Sesimbra, Setúbal; Lapa do Médico, Portinho da Arrábida, Palmela, Setúbal; Cova da Adiça, Moura, Beja; Gruta

da Seiceira, Aljezur, Faro; Algarão menor do Paulino, Cerro da Cabeça Gorda, Loulé, Faro; Solestreira Pequena, Querença; Igreja de Soidos, Alte, Loulé, Faro; Algueirão dos Mouros, Pechão, Olhão, Faro; Abismo Novo, Moncarapacho, Olhão, Faro; Algarão do Garrafão, Cerro da Cabeça, Olhão, Faro; Ladroeira Pequena, Cerro da Cabeça, Olhão, Faro (Vandel 1946).

### **Distribution**

Species widely distributed in Europe and introduced to many other parts of the world.

### **Ecological notes**

This species is a common inhabitant of caves and other subterranean habitats. It has no morphological adaptations to cave life and can be considered as a troglophile.

#### *Porcellio dispar* Verhoeff, 1901

*Porcellio dispar* Verhoeff, 1901: 407.

*Porcellio dispar* – Vandel 1946: 289, figs 110–111.

### **Records**

Algar n° 2 do Pinheiro, Benedita (Vandel 1946).

### **Distribution**

Portugal.

### **Ecological notes**

Epigeal species, troglone.

#### *Porcellio echinatus* Lucas, 1849

*Porcellio echinatus* Lucas, 1849: 69, pl. 7, fig. 1.

*Porcellio echinatus* – Vandel 1946: 304, figs 125–130.

### **Records**

Algar da Serra, Alvaiázere (Vandel 1946).

### **Distribution**

Southern Portugal, southern Spain, northern Morocco, and north-western Algeria.

### **Ecological notes**

Epigeal species, troglone.

#### Family Armadillidiidae Brandt, 1833

#### Genus *Eluma* Budde-Lund, 1885

#### *Eluma caelata* (Miers, 1877)

*Armadillidium caelatum* Miers, 1877: 665, pl. 7, fig. 3.

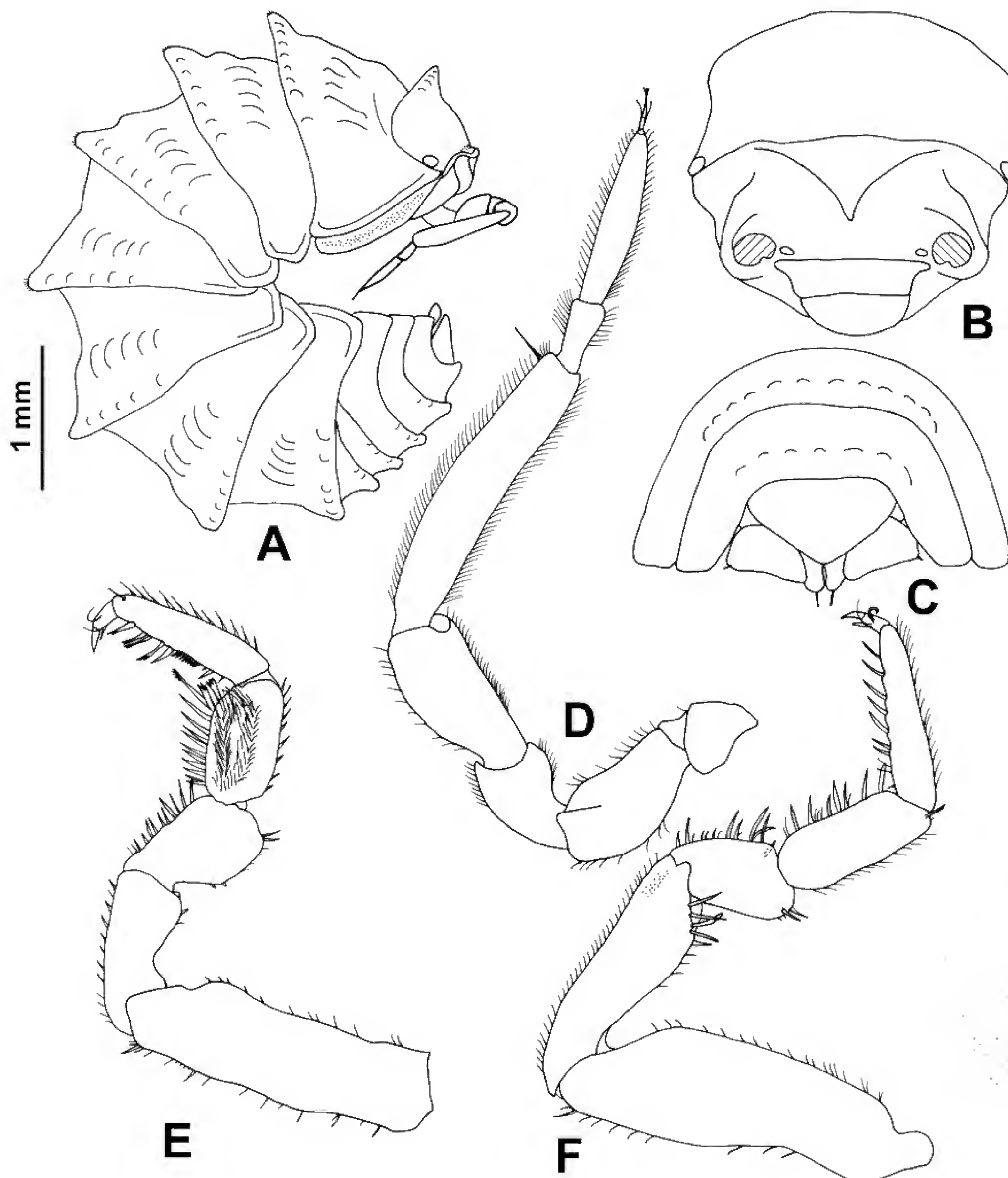
*Eluma purpurascens* – Vandel 1946: 357, fig. 158 (not Budde-Lund, 1885).

### **Records**

Algarve das Gralhas, Cadaval, Montejunto Massif (Vandel 1946).

### Distribution

Southern British Isles, western France, Portugal, Azores, Madeira, Canary Islands, mainland Spain and north-western Africa. It has been introduced to Tasmania and French Guyana.



**Fig. 30.** *Eluma tuberculata* Cruz, 1991 from Gruta do Soprador do Carvalho, Sicó. — ♀. **A.** Specimen in lateral view. **B.** Cephalon in frontal view. **C.** Pleonites 4, 5, telson and uropods. — ♂. **D.** Antenna. **E.** Pereopod 1. **F.** Pereopod 7.



**Remarks**

The genus *Eluma* includes three epigean species: *E. caelata*, *E. tuberculata* Cruz, 1991 from Portugal (see below), and *E. praticola* Taiti & Rossano, 2015 from the Rif region in Morocco. *Eluma caelata* has been fully illustrated by Taiti & Rossano (2015: figs 32–33).

**Ecological notes**

Epigean species, troglaxene.

***Eluma tuberculata* Cruz, 1991**

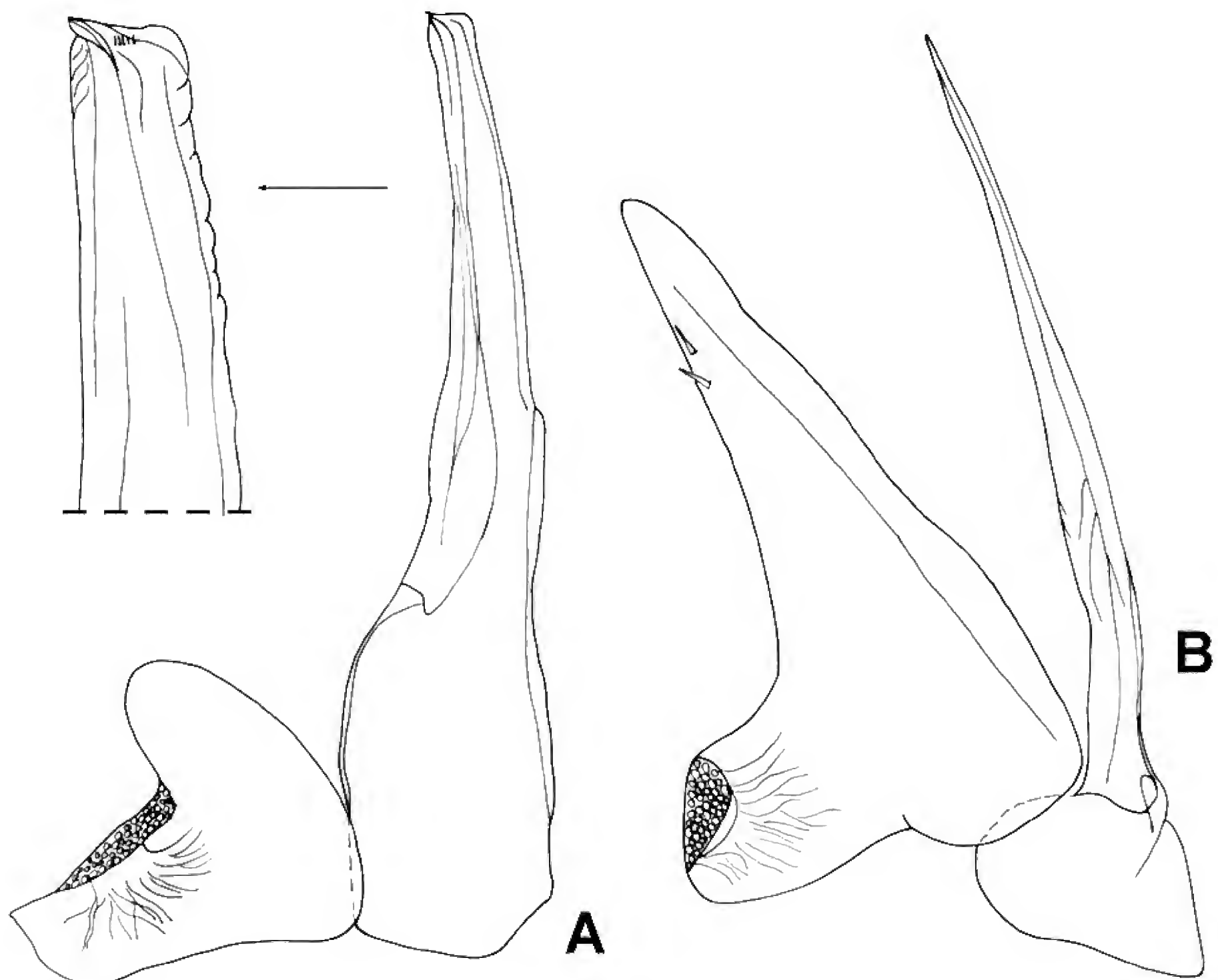
Figs 30A–F, 31A–B

*Eluma tuberculata* Cruz, 1991: 73, fig. 1a–f.

*Eluma tuberculata* – Schmalzfuss 2003: 107.

**Material examined**

PORTUGAL: many ♂♂ and ♀♀, mesovoid shallow substratum (MSS) near Gruta das Alcobertas, Estremenho Massif (MZUF); 1 ♀, Gruta do Soprador do Carvalho, Sicó Massif, 30 Aug. 2007 (SR); 4 ♂♂, 4 ♀♀, 2 juvs, same locality, 30 Aug. 2009 (SR); 5 ♂♂, 6 ♀♀, same locality, 20 Nov. 2009 (ZMUC).



**Fig. 31.** *Eluma tuberculata* Cruz, 1991 from Gruta do Soprador do Carvalho, Sicó, ♂. **A.** Pleopod 1. **B.** Pleopod 2.

### Previous records

São Mamede, Fátima (Cruz 1991).

### Distribution

This species seems to be endemic to central Portugal.

### Remarks

*Eluma tuberculata* was described by Cruz (1991) based on two females from São Mamede, Fátima. The numerous specimens collected during our research allow us to illustrate the species with its most important features, i.e., the tuberculated body and the schisma on pereonite 1 (Fig. 30A), the cephalon (Fig. 30B), the telson and uropods (Fig. 30C), and the antenna (Fig. 30D). This species has a very plastic morphology concerning the dorsal tubercles, which may be more or less developed. The presence of several adult males permits the description of the male characters which were previously unknown: Pereopods 1 (Fig. 30E) to 6 with brushes of setae on sternal margins of merus and carpus. Pereopod 7 (Fig. 30F) ischium narrow, with straight sternal margin and a ridge on distal part of caudal surface. Pleopod 1 (Fig. 31A) exopod with long, rounded median lobe directed outwards, endopod with distal half having parallel sides and small recurved and pointed apical part not protruding outwards. Pleopod 2 (Fig. 31B) exopod triangular and slightly shorter than endopod.

### Ecological notes

This troglophilic species was collected with traps in the MSS (mesovoid shallow substratum, or ‘milieu souterrain superficiel’ *sensu* Juberthie *et al.* 1980) in the Estremenho Massif as well as in a cave (Gruta Soprador do Carvalho) in Sicó.

Genus *Paraschizidium* Verhoeff, 1918

*Paraschizidium* sp.

Fig. 32A–E

### Material examined

PORTUGAL: 4 ♀♀, Algar do Javali, Montejunto Massif, 19 Sep. 2009 (MZUF); 6 ♀♀, same locality, 24 Dec. 2009 (SR).

### Remarks

At present, the genus *Paraschizidium* includes with certainty only three species: *P. coeculum* (Silvestri, 1897), distributed from Spain to the Balkans, *P. hispanum* Arcangeli, 1935 from southern Spain, and *P. roubali* Frankenberger, 1940 from Prague, Czech Republic (Frankenberger 1940), which is probably a junior synonym of *P. coeculum* (see Manicasterri & Taiti 1994). Other species from Greece originally included in the genus *Paraschizidium* by Schmalfuss (1981) and Sfenthourakis (1992, 1995) were transferred to the genus *Schizidium* Verhoeff, 1901 by Schmalfuss (2008). Our specimens certainly belong to the genus *Paraschizidium*: they are depigmented and blind, have no schisma at the postero-lateral corner of the pereonite 1 (Fig. 32A), the cephalon has oblique antennal lobes (Fig. 32B–C), the telson is short and triangular (Fig. 32D) and the antennula has two articles (Fig. 32E). Unfortunately, the absence of males in our material does not permit the identification of these specimens to species level.

Genus *Trogleluma* Vandel, 1946

### Remarks

*Trogleluma* was erected by Vandel (1946) as a subgenus of *Troglarmadillidium* Verhoeff, 1900 to include the new species *Troglarmadillidium (Trogleluma) machadoi* from two caves in South Portugal (see below). At present, the genus *Troglarmadillidium* only includes the monospecific subgenera

*Troglarmadillidium* and *Trogleluma*, with the species *T. (Troglarmadillidium) stygium* (Verhoeff, 1900) from Herzegovina, and *T. (Trogleluma) machadoi*. Both these species have a depigmented body, are blind, have no schisma at the postero-lateral corner of pereonite 1, a triangular telson, and uropods with the exopodite flattened, longer than wide. The two subgenera show quite distinct morphological traits in the cephalic structure: in *Troglarmadillidium* the triangular frontal scutellum of the cephalon, frontal line and antennal lobes are missing, while in *Trogleluma* these structures are present. These characters have been confirmed after the examination of a female specimen of *T. (Troglarmadillidium) stygium* from Montenegro (Crna Gora, Danilovgrad, Tunjevo, Milojevića vrela, 26 Apr. 1997, leg. and det. I. Karaman). On the basis of these characters we consider *Trogleluma* as a distinct genus from *Troglarmadillidium*. *Trogleluma* includes the type species, *Trogleluma machadoi*, and a few undescribed new species from Sardinia and Tuscany in Italy (Taiti 2007, unpublished results).

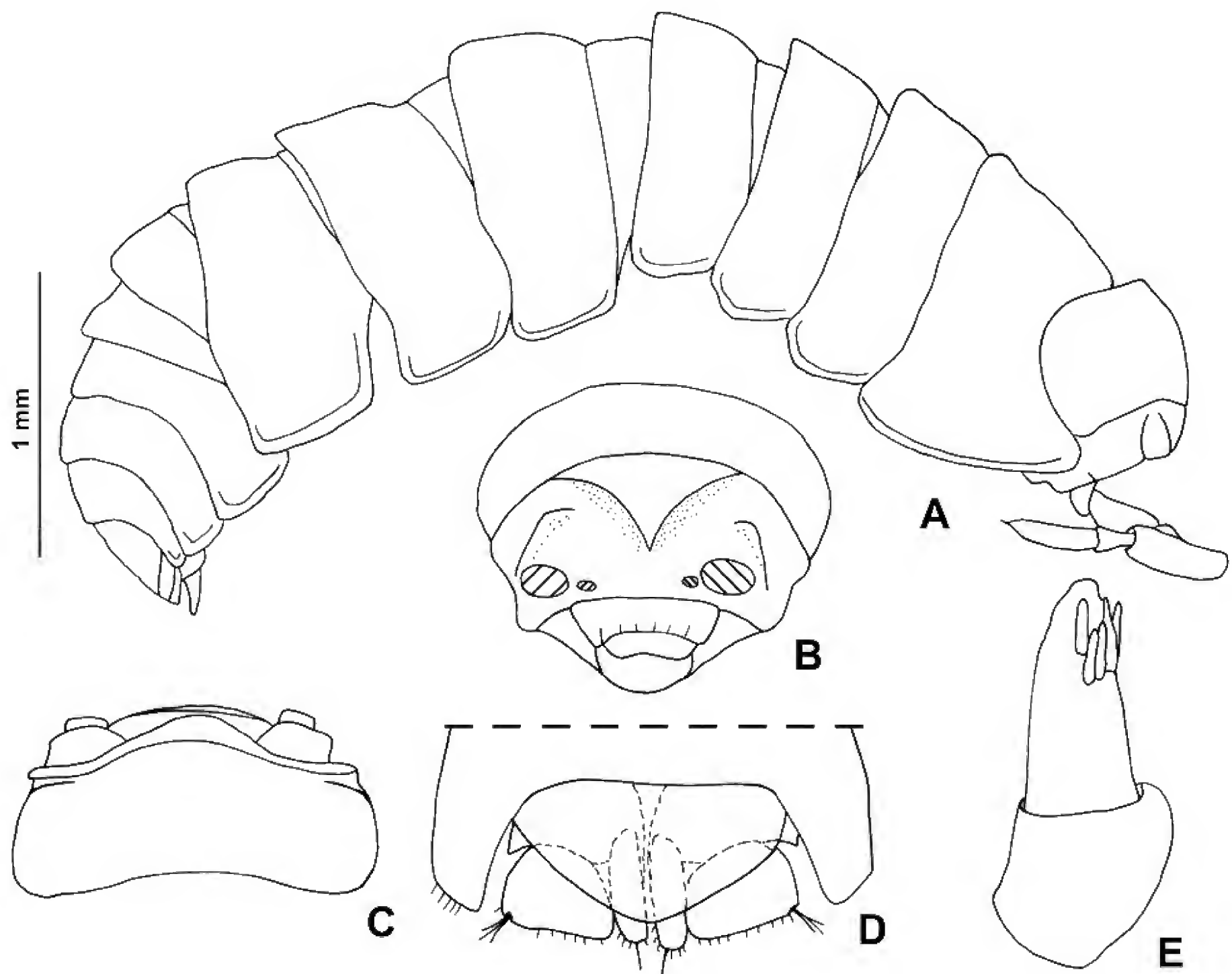
***Trogleluma machadoi* (Vandel, 1946)**

Figs 33A–J, 34A–E

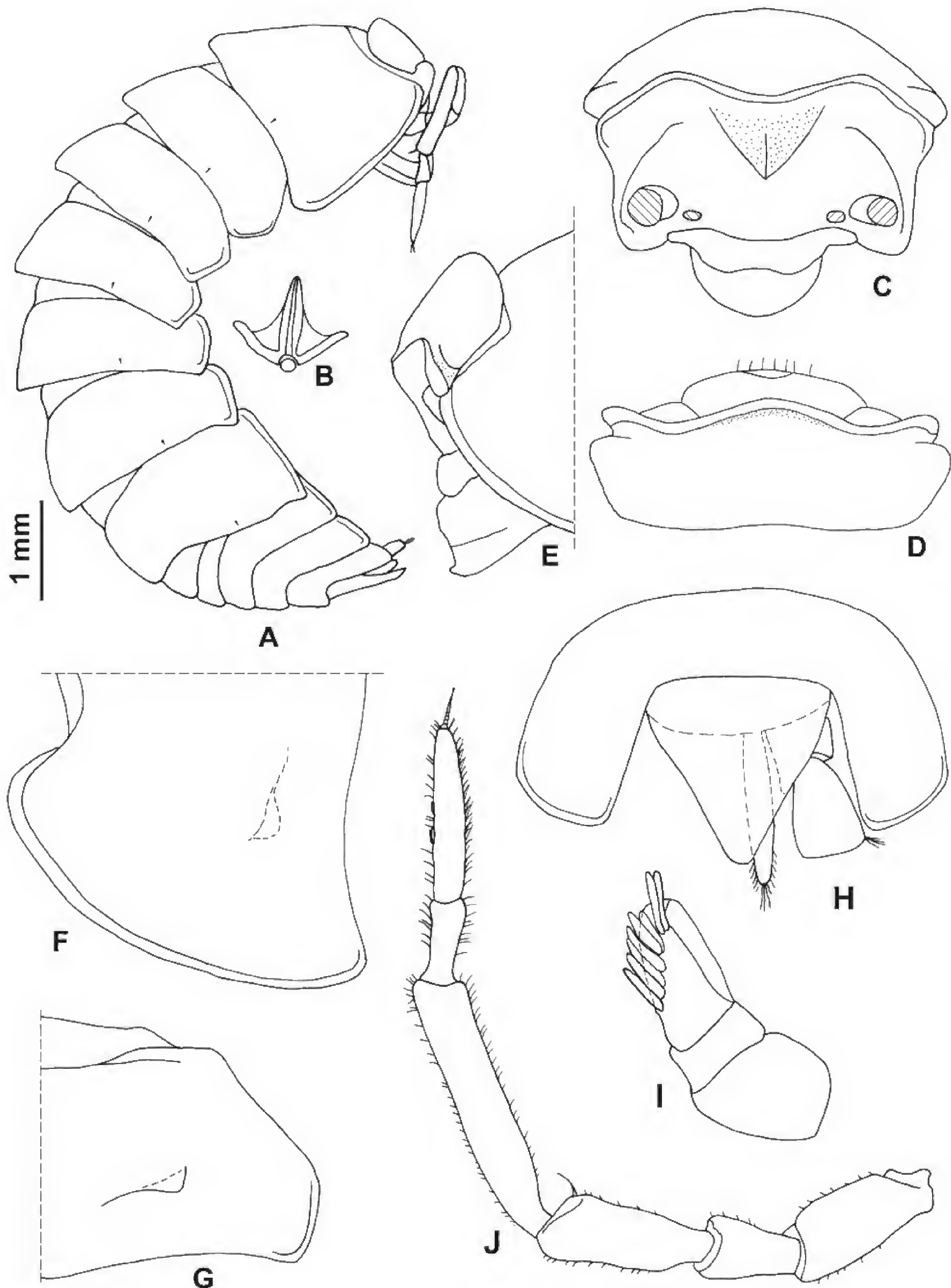
*Troglarmadillidium (Trogleluma) machadoi* Vandel, 1946: 361, figs 148–157.

*Troglarmadillidium (Trogleluma) machadoi* – Schmölzer 1965: 307, figs 1232–1233; 1971: 62.

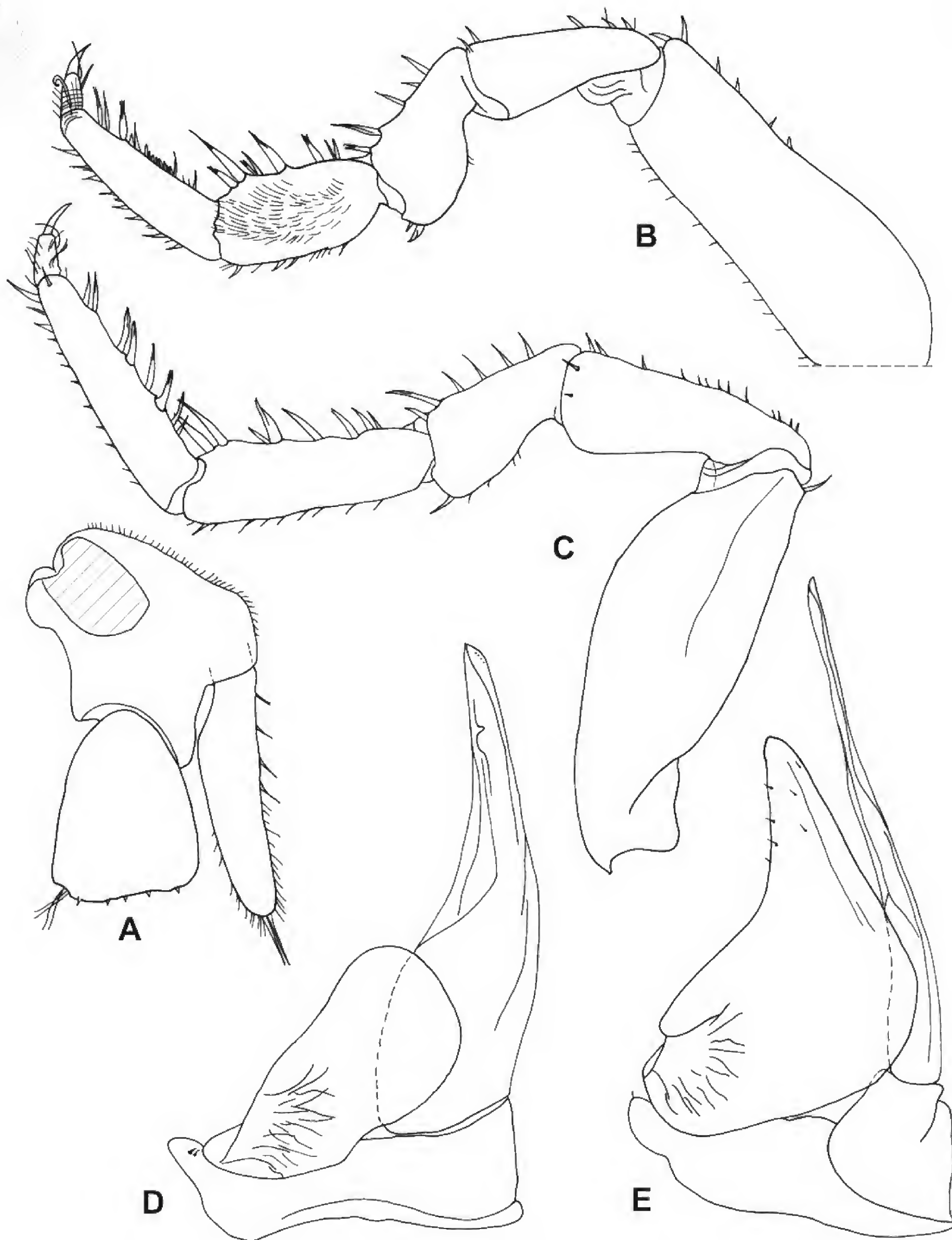
*Troglarmadillidium machadoi* – Schmölzer 1971: 106, 155. — Schmalfuss 2003: 319. — Reboleira *et al.* 2011a: 7, table 1.



**Fig. 32.** *Paraschizidium* sp. from Algar do Javali, Montejunto, ♀. **A.** Specimen in lateral view. **B.** Cephalon in frontal view. **C.** Cephalon in dorsal view. **D.** Pleonite 5, telson and uropods. **E.** Antennula.



**Fig. 33.** *Trogleluma machadoi* (Vandel, 1946) from Algarão do Remexido, Algarve. — ♀. **A.** Specimen in lateral view. **B.** Scale-seta. — ♂. **C.** Cephalon in frontal view. **D.** Cephalon in dorsal view. **E.** Cephalon in lateral view. **F.** Epimeron of pereonite 1 in dorsal view. **G.** Epimeron of pereonite 2 in ventral view. **H.** Pleonite 5, telson and right uropod. **I.** Antennula. **J.** Antenna.



**Fig. 34.** *Trogleluma machadoi* (Vandel, 1946) from Algarão do Remexido, Algarve, ♂. **A.** Uropod. **B.** Pereopod 1. **C.** Pereopod 7. **D.** Pleopod 1. **E.** Pleopod 2.

### Material examined

PORTUGAL: many ♂♂ and ♀♀, Gruta de Ibne Ammar, 23 May 2009 (MZUF); many ♂♂ and ♀♀, Algarão do Remexido, 5 Sep. 2009 (MZUF); many ♂♂ and ♀♀, same locality, 29 Dec. 2009 (SR); 5 ♂♂, 7 ♀♀, same locality, 23 May 2009 (ZMUC); 6 ♂♂, 8 ♀♀, same locality, 15 Mar. 2009 (SR); 1 juv., same locality, 5 Sep. 2009 (SR); many ♂♂ and ♀♀, Gruta da Senhora; all caves in the Algarve Massif (MZUF).

### Previous records

Algarão Menor do Paulino, Serro da Cabeça Gorda, Loulé, Faro; Abismo Novo, Moncarapacho, Olhão, Faro, Algarve Province (Vandel 1946).

### Distribution

Endemic to caves of the Algarve, the southernmost province of Portugal.

### Remarks

The species is here fully illustrated (Figs 33–34) to facilitate its recognition.

### Ecological notes

Troglobiotic species. The specimens were mostly found inside the clay, which often covers their integument, an observation already pointed out by Vandel (1946). Some individuals were also found walking on cave walls and completely clean of clay. In the caves of the Algarve, this species occurs together with other remarkable troglobiotic species: the pseudoscorpions *Titanobochica magna* Zaragoza & Reboleira, 2010 and *Lusoblothrus aenigmaticus* Zaragoza & Reboleira, 2012; the spiders *Harpactea stalitoides* Ribera, 1993 and *Teloleptoneta synthetica* Machado, 1951; the millipedes *Boreviulisoma barrocalense* Reboleira & Enghoff, 2013, *Acipes machadoi* Enghoff & Reboleira, 2013, and *A. bifillum* Enghoff & Reboleira, 2013; the campodeid *Litocampa mendesi* Sendra & Reboleira, 2010; and the giant thysanuran *Squamatinia algharbica* Mendes & Reboleira, 2012 (Reboleira *et al.* 2010c, 2012a, 2012b; Reboleira & Enghoff 2013; Enghoff & Reboleira 2013b).

### Discussion

Terrestrial isopods are the most diverse taxonomic group of troglobionts (Reboleira *et al.* 2013b) in the caves of Portugal, with the number of known species doubled with the present work. The Portuguese oniscidean fauna is now composed of 16 troglobiotic species in mainland Portugal, 5 troglaphiles and 6 troglloxenes (Table 2). Two additional species are known from the volcanic caves of the Portuguese Atlantic islands: *Trichoniscus bassoti* Vandel, 1960 from Madeira (Vandel 1960b; Reboleira *et al.* 2011a), and a new, still undescribed, trichoniscid from the Azores (Borges *et al.* 2012). For comparison, 27 species of troglobiotic Oniscidea are known from Spain and 64 from Italy (including Sardinia and Sicily), most of which belonging to the family Trichoniscidae (25 and 57 species, respectively).

Trichoniscidae is also the richest family in Portugal, with 14 species frequently found in caves of mainland Portugal, 12 of which are considered to be true troglobionts. *Trichoniscoides* is the most diverse genus. *Trichoniscoides machadoi* is an endogean and cavernicolous species occurring in different regions of Portugal, while the remaining species are restricted to single karst areas: *T. serrai* to the palaeokarst of Vimioso in northeastern Portugal; *T. broteroi* to the northern part of the Sicó Massif; *T. sicoensis* to the central area of Sicó; and three species to the Estremenho Massif, the largest karst area of Portugal, i.e., *T. meridionalis* distributed in caves along its three main central subunits (Serra dos Candeeiros, Santo António Plateau and Serra de Aire/São Mamede Plateau), *T. subterraneus* in the Aljubarrota Plateau at

**Table 2.** Terrestrial isopod species recorded in subterranean habitats of karst areas from Portugal, with ecological classification. Tb = troglobiont; Tph = troglophile; Tx = troglaxene.

Family	Species	Ecology	Karst area
Trichoniscidae	<i>Trichoniscoides broteroi</i>	Tb	Sicó
	<i>Trichoniscoides machadoi</i>	Tph	widespread
	<i>Trichoniscoides ouremensis</i>	Tb	Estremenho
	<i>Trichoniscoides serrai</i>	Tb	Vimioso
	<i>Trichoniscoides subterraneus</i>	Tb	Estremenho
	<i>Trichoniscoides meridionalis</i>	Tb	Estremenho
	<i>Trichoniscoides bellesi</i>	Tb	Sicó
	<i>Trichoniscoides sicoensis</i>	Tb	Sicó
	<i>Metatriconiscoides salirensis</i>	Tb	Caldas da Rainha
	<i>Troglonethes olissipoensis</i>	Tb	Lisbon Peninsula
	<i>Troglonethes arrabidaensis</i>	Tb	Arrábida
	<i>Miktoniscus longispina</i>	Tb	Cesaredas and Sicó
	<i>Haplophthalmus siculus</i>	Tx	Lisbon Peninsula
	<i>Moserius inexpectatus</i>	Tb	Estremenho
	Styloniscidae	<i>Cordioniscus lusitanicus</i>	Tb
Philosciidae	<i>Anaphiloscia sicula</i>	Tph	Algarve
	<i>Ctenoscia minima</i>	Tx	Algarve and Lisbon Peninsula
Platyarthridae	<i>Trichorhina anophthalma</i>	Tph	Alentejo
Porcellionidae	<i>Porcellionides pruinosus</i>	Tx	widespread
	<i>Porcellionides sexfasciatus</i>	Tx	Algarve
	<i>Porcellionides cingendus</i>	Tx	Estremenho
	<i>Porcellio cavernicolus</i>	Tb	Sicó and Catanhede
	<i>Porcellio dilatatus</i>	Tph	widespread
Armadillidiidae	<i>Eluma caelata</i>	Tx	Montejunto
	<i>Eluma tuberculata</i>	Tph	Sicó and Estremenho
	<i>Paraschizidium</i> sp.	Tb	Montejunto
	<i>Trogleluma machadoi</i>	Tb	Algarve

the western part of the massif, and *T. ouremensis* in the Fátima Plateau, the eastern part of Estremenho. Despite the sampling effort at their type localities, the troglotrophic species *Trichoniscoides broteroi*, *T. serrai*, *T. ouremensis* and *T. subterraneus* were not found during our research. The Iberian genus *Troglonethes* now also includes two species from central Portugal: *T. olissipoensis* Reboleira & Taiti sp. nov. from a cave of the Lisbon Peninsula, and *T. arrabidaensis* Reboleira & Taiti sp. nov. from a cave in the Arrábida Massif. *Miktoniscus longispina* Reboleira & Taiti sp. nov. was collected in two different karst areas: Sicó and the Cesaredas Plateau, the specimens from these localities presenting slight morphological differences from each other.

The styloniscid *Cordioniscus lusitanicus* Reboleira & Taiti sp. nov. is described from caves of the Alentejo and Algarve karst areas, more than 200 km apart in the south of Portugal.

The family Platyarthridae is represented by the species *Trichorhina anophthalma*, described from endogean habitats in Palmela, the Arrábida karst massif and Serpa (Baixo Alentejo), but recently also found in karst caves of Alandroal in central Alentejo and in the Algarve.

The family Porcellionidae has one troglobiotic species, *Porcellio cavernicolus*, described from the Sicó Massif, but now found in caves of the Outil-Cantanhede and Mealhada karst areas, north of the Mondego River, and also inhabiting caves in the Tomar region, significantly increasing its former area of distribution. Slight morphological differences can easily be observed between the extremes of its area of distribution, and molecular studies may clarify the taxonomy of these isolated populations. This species is particularly abundant in shallow caves with roots pending from the ceiling. The troglomorphic *Porcellio dilatatus dilatatus* is very abundant in the most superficial parts of caves from all of Portugal, a feature already pointed out by Vandel (1946).

The family Armadillidiidae is represented by four species belonging to the genera *Eluma*, *Paraschizidium* and *Trogleluma*. The genus *Eluma* includes the epigean *E. caelata* and *E. tuberculata*, originally described from specimens collected under stones in the eastern subunit of the Estremenho Massif (Cruz 1991) and now found in the MSS on the western border of the same massif and also in one cave of Sicó. It appears to be distributed along the MSS, being found inside caves only in their most superficial areas. One cave-adapted species of *Paraschizidium* was found in a cave of the Montejunto Massif and represents the first record of this genus in Portugal. *Trogleluma machadoi* is widely distributed in caves along the Barrocal area in the Algarve karst massif.

From a biospeleological point of view, mainland Portugal is traditionally divided into two main areas, the Lusitanian district in central Portugal, and the Baetic district in the south, including the Algarve and extending to Andalucía in Spain (Bellés 1987; Reboleira *et al.* 2011a). The pattern of troglobiont richness for terrestrial isopods reinforces this separation, with the Lusitanian district clearly rich in troglobiotic species of the genus *Trichoniscoides* and the Baetic district characterised by the presence of the genera *Trogleluma* and *Cordioniscus*.

The recent rise in the number of known subterranean species is a result of the extensive use of a standard sampling methodology in a large number of karst caves, which has also provided new taxa of other cave-adapted arthropod groups (Reboleira 2012; Reboleira *et al.* 2009, 2010a, 2010b, 2010c, 2011b, 2012a, 2012b, 2013b; Reboleira & Enghoff 2014a). The richness of terrestrial isopods in the subterranean ecosystems of Portugal, and by extension of the Iberian Peninsula, requires a consistent sampling effort to reach a complete level of evaluation.

Terrestrial isopods have been used as bioindicators in land ecosystems, since they are extremely sensitive to contaminants (Paoletti & Hassall 1999; Paoletti *et al.* 2007). In the same way, the presence of troglobiotic Oniscidea can be used as indicators of subterranean ecosystem health. A strong argument in support of this is their basal trophic position in cave communities. Decomposing detritus and their strong dependence on water makes them more vulnerable to contamination. The presence of troglobiotic oniscidean species is generally related to deep, stable and undisturbed parts of caves, while in the most disturbed areas only troglonexes or, at most, troglophile isopods are present, suggesting that they can be used as indicators of the quality of the subterranean ecosystems that they occupy. An example of this is provided by the Gruta dos Moinhos Velhos, with a 300 m long show cave branch, where only the troglophile *Porcellio dilatatus dilatatus* is abundant, while the troglobiont *Trichoniscoides meridionalis* occurs only in the undisturbed galleries, far from human impact. All troglobiotic species of Oniscidea in Portugal lack formal protection (Reboleira *et al.* 2013a) and their biodiversity patterns should be considered for sustainable management of karst areas in such an important world biodiversity hotspot.



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